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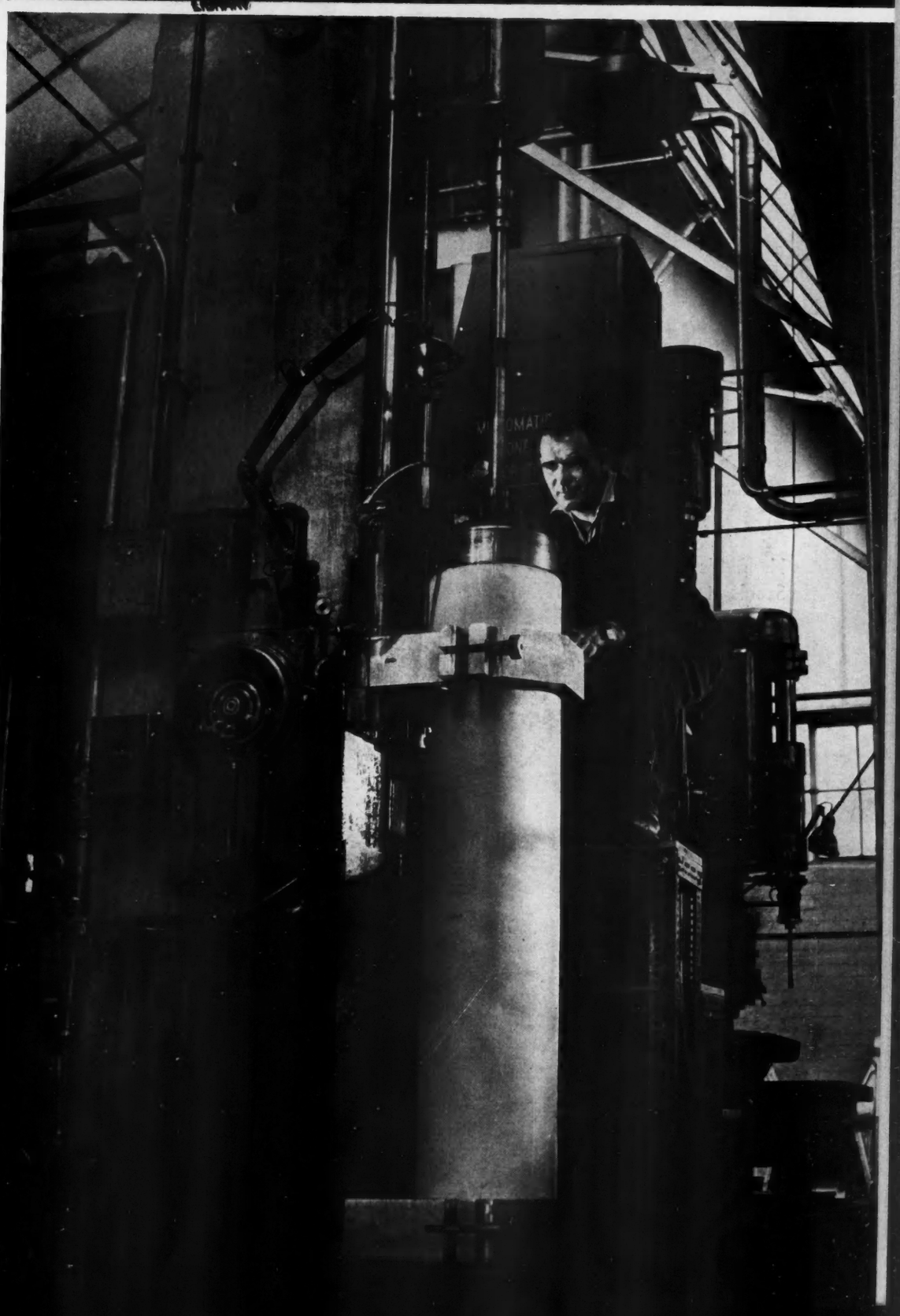

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The Forth Road Bridge
Superstructure

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Wider Use
of Hydraulic Models

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Layshaft Gears
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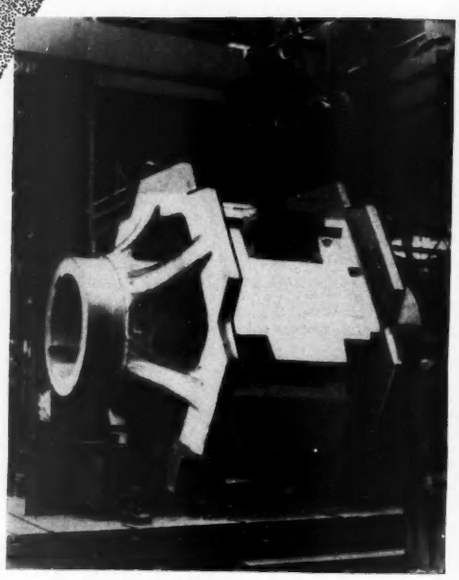

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PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone: Temple Bar 3663

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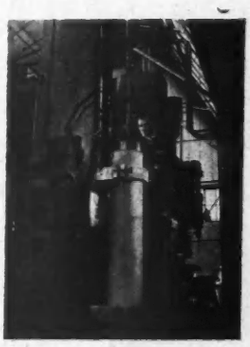

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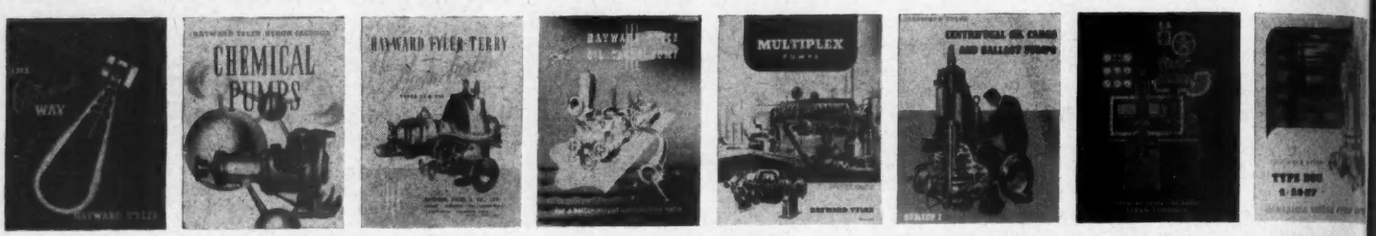

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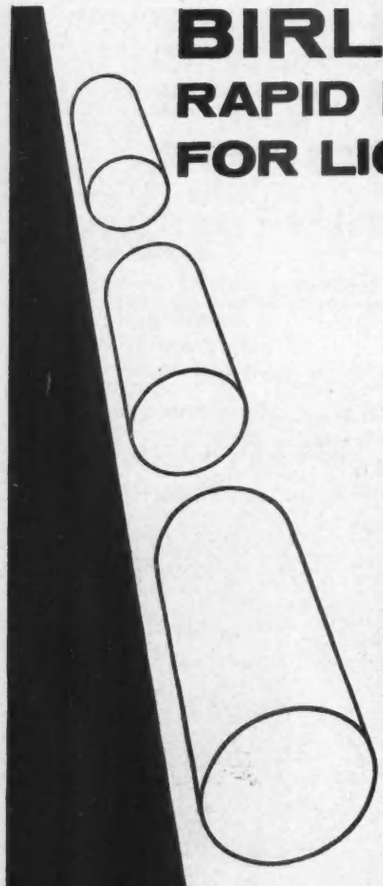

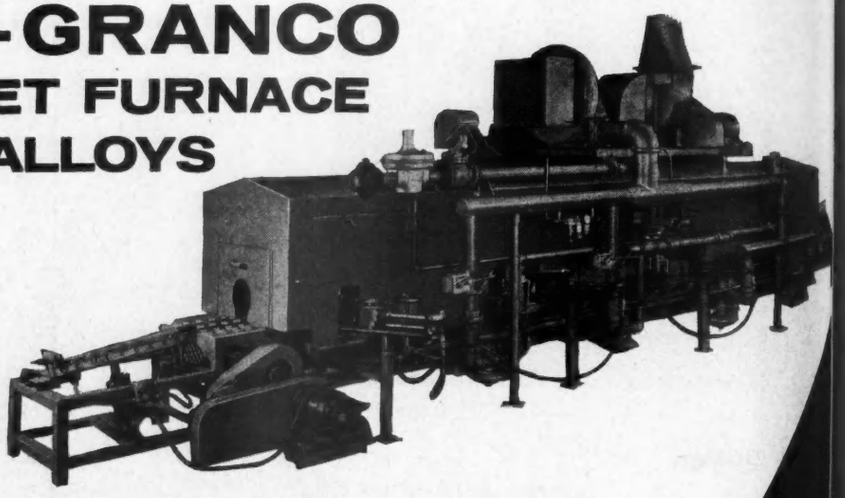

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ENGINEERING Impact

of A Payroll Tax to Promote Efficiency

EXHORTATIONS to industry, to install the most advanced equipment and to apply only the most efficient methods, are outnumbered only by the laments that the principal factor holding back the much needed improvement in productivity in the United Kingdom is the shortage of labour and the slowness of movement from jobs of low productivity to those where it is high.

That appeals are ineffective is apparent from the slow motion rise in United Kingdom output in contrast to the fast advancing productive efforts of such profitable economies as Western Germany, Italy and now France.

Further examination of the problems are only likely to be given attention in so far as they contain believable prospects of a cure for the troubles, or a method for accelerating our economic growth to the point where the United Kingdom becomes a credit earning community and not one with a permanent trading debt.

Consideration of the arguments marshalled by Political and Economic Planning for the use of a payroll tax, in place, it is suggested, of the present profits tax and local rate contributions, suggests that the thought given to the proposition in recent years has brought it to a position where those in industry may reasonably begin to ask when some action along these lines will be embodied in the budget.

PEP put forward the figure of 3 per cent for the hypothetical payroll tax, since this would cover industry's profits tax and local rates (as in 1959) and leave a substantial bonus for the Exchequer. The calculation is set out in the Table.

On the face of it this is simply another way of increasing the tax revenues. In practice it holds out the hope of a revolution in the way that taxation, whether national or local, falls upon new investment for production and upon the employment of the industrial labour force.

As taxes are at present imposed in Britain, the take-it-easy concern, with 200 men in a cramped inadequate building, making low profits and nothing much of a contribution to the export trade, will be paying less local rate contribution, and very much less in profits tax, than the vigorous hard working management with the same number of men in the larger and better planned new works next door, whose local rates will be heavier and whose profits tax perhaps many times greater.

A payroll tax would equalise the burden on the two firms, apart from the question of overtime, and the effects would very possibly be dramatic. For the progressive companies, the incentive to go ahead at full speed with new building, new equipment and all the effort of raising targets and working for new markets would be greater. For those who have been happily rubbing along, the very least of the possibilities is that it would appear desirable to step up capital investment and cut down on the labour force. The incidental effect in freeing men to move to concerns held back from the goals their managements believe could be reached, if it were not for shortages of the sort of men they need, could be as great for the British economy as the two chief sources of fresh industrial labour have been in the '50s for France and Western Germany. France has been able to draw into her factories numbers of men from a largely agricultural economy. Western Germany has made good use of people flowing in from the unemployed regions of Spain and from Italy and of new recruits to the labour force crossing the border from Eastern Germany.

With full employment continuing from the war years, Britain has had no such infusion of new numbers, though Commonwealth immigration has played some part, as the Pakistanis in the foundries and the West Indians on public transport testify.

A new impetus behind investment in labour saving machines, and some tax relief to those industries where vast capital undertakings have been undertaken, is the best hope for raising the amount of extra value which our industrial skill can add to the raw material imports. The payroll tax looks the likeliest proposition yet offered.

Table: Effect of a 3 per cent Payroll Tax (1959 estimates)

	£ million
Total wage and salary bill	12,560
Product of 3 per cent payroll tax	377
Total of profits tax	258
Amount paid by industry in local rates (approx)	73
	331
Balance to Exchequer	46

It is worth examining a particular industry against the 3 per cent proposal. The steel companies are constantly in the news with heavy development programmes in Scotland, South Wales and elsewhere, pushing up their total output, introducing oxygen and other modern processes to produce, at Llanwern, Ravenscraig, and so on, steelmaking capacity that is technically competitive with anything in the world.

But the cost of the local rates, for these multi-million pound schemes, spreading over thousands of acres of land, is enormous, putting shillings on the cost of every ton of steel. And pushing up the cost of almost everything we export, for even those manufactured goods which do not contain steel were without exception produced by machines and people whose cost of living is affected by the price of steel.

The payroll tax would, in PEP's report of published estimates, cut the cost of finished steel by some 10*s* a ton. After 1963, if full industrial derating is carried through, the saving on each ton would be of a very much higher order. One of the most advanced of the steel companies gave ENGINEERING the following figures when asked the likely effect on its own finances of a 3 per cent payroll tax. For the year ended September, 1960, the figures were:

Profits tax	£1,300,000
Local rates	£1,400,000
Total	£2,700,000
Payroll Tax of 3 per cent	£750,000

For another of the major companies—the United Steel Companies—there would be a similar saving. In the financial year ending 30 September 1960, United Steel paid £2,098,000 in profits tax. The estimated local rate contribution was £847,000. On the total wages and salaries bill for the year of £31,509,000, a 3 per cent payroll tax would amount to £945,000.

Cutting Steel Costs

When it is remembered how much of the hopes for Britain's future exports lie with heavy engineering, the significance of such savings is apparent. It is a sad commentary on what the senior executives expect that those who, talking to this journal, were most enthusiastic were also the most pessimistic about the possibility of seeing the payroll tax introduced.

If iron and steel and the shipyards were to benefit, who would suffer? In general the industries of high labour employment in relation to their capital—coal, agriculture, the services. It has been estimated that a 3 per cent payroll tax would put 9*d* on each ton of coal. Since the net drop of 10*s* in a ton of finished steel was estimated bearing this increase in the coal price in mind, manufacturing industry would have savings to set against the greater outgoings, without taking into account direct benefits from such a scheme.

Agriculture with its supports and subsidies would plainly be a difficult problem. But if the same amount of public assistance was to be given to farmers, apportioning it would be a straight political exercise. On the farms the impact of a payroll tax would, as elsewhere, be one more force pushing the already considerable performance in increased productivity to higher levels.

Perhaps in the effects of the payroll tax on the service occupations the gains for the national economy would be greatest of all. One of the most often heard complaints in economic arguments is that every step upward in national production is surely swallowed up by rising standards of living. The effect of the payroll tax would be, at first, more in the nature of a reshuffle. down with the cost of certain manufactured products, up with the cost of services where the greater part of the charge is the labour of the man or woman doing the service. This could be seen to be self-balancing.

A wage claim based on costlier haircuts could, or should, be swiftly countered by pointing to the lower price of washing machines (or even scissors).

Informed comparisons of the incidence of taxes on capital earnings as between the European countries and the United Kingdom are hard to come by but PEP reports that, from a limited cross-section of companies, it appears that the countries of the European Economic Community impose a much lower burden of capital taxes than is the case in Britain.

The key to the similarity between European labour costs and those in Britain is that while rates per hour in the UK are well above West Germany and France, and almost double those of Italy, the amount of social contributions levied on industry in Europe is very much heavier than has been the case here.

Tunnel, Tube or Bridge

Whatever the views of governments on the establishment of a direct route across the English Channel, engineers seem assured that an early start should be made. But should it be a tunnel, a tube laid on the sea bed, or a bridge . . . or even a barrage supporting a roadway with, presumably, the means of giving passage to ships? Judging by the numbers that turned up at the Institution of Civil Engineers last week when the subject was discussed—the meeting was transferred from the lecture hall to the Grand Hall because of the numbers—the profession regard it as worthy of serious and urgent discussion.

As is well known the Channel Tunnel Study Group, whose representatives gave the paper to the Institution, came down firmly in favour of twin railway tunnels, operating on 25,000 kV electric traction. With modern signalling, trains could work with a headway of only five minutes and over 1,800 vehicles an hour could be conveyed in both directions. On the other hand, the best the Group could see for the larger road tunnels, with their more expensive ventilation system, was 1,300 vehicles in both directions.

The fact that the Study Group had examined and rejected the possibilities of a tube or a bridge, and a combination route with a bridge as far as the Varne Bank in mid-Channel followed by a tunnel, did not stop the supporters of such routes from putting their case. A glance at a map showing the sea routes and the numbers of vessels moving through the Channel, and the number of cable crossings that are already in existence, shows one of the lesser problems of siting piers for the bridge or ventilation shafts.

Minimum Capital Risk

Could a tunnel be driven through the green chalk without meeting water-bearing fissures that are impassable? As the geologist from the Study Group was quick to admit, their work so far in this respect has been but a feasibility investigation, not a site construction survey. But on the evidence, the tunnel seemed practicable. Critics of the tube or bridge pointed out the difficulties of immersing the tubes or sinking the piers on a scale and in such currents that were not merely larger, but very much larger, than anything yet attempted. To this the tube and bridge supporters retorted that they preferred the calculated risks of manoeuvring the tubes or building the piers to the uncertainties of driving the tunnel through unproved chalk where the impassable fault might not be met until the job was nearly completed and most of the capital committed.

The Study Group believe their tunnel and trains can meet traffic requirements for "many years to come." Their estimates of traffic growth were severely criticised and consultant and contractor alike would probably agree that the best for the profession and industry would be a tunnel, a tube *and* a bridge.

Spraying Urethane Foams for Insulation

Aerograph - DeVilbiss have launched resins and equipment for spraying urethane foams which will compete with ICI's methods. Thermal insulation values are particularly good.

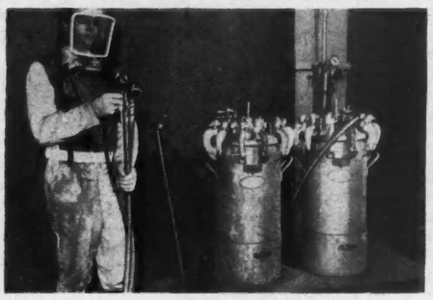
FEW people would deny that the main credit must go to ICI for development of polyurethane foams in the United Kingdom. During the past ten years they have taken these out of the laboratory and into industry—where they can now be dispensed cleanly and straightforwardly to produce foams-in-place. Together with a firm called Viking Engineering they have developed metering, dispensing and spraying equipment, and examples of these are illustrated here.

Most people would be familiar with foams and the idea that they offer good insulation against transmission of heat, sound, corrosive media and even impact forces. These properties, of course, promise to bring polyurethane (often called urethane) foams right into the home of the fabricator. But, with due respect to those who have an interest in chemistry, this end-user is not normally going to be interested in chemical formulations. What he wants to know is what they cost, how easy they are to apply, and what properties foams have to offer.

It is in striving to find simple answers to these questions that a newcomer to the scene, Aerograph-DeVilbiss, will probably give the other firms a lot of competition. Present indications are that their avowed intention of making equipment simpler than that already on the market has been fulfilled. Following American experience in which DeVilbiss developed a spray gun and Wyandotte Chemicals produced a chemical formulation (launched last year in the USA), Aerograph have got together with Baxenden Chemicals in the UK to produce a similar system.

These urethane foams are quite complex chemically but have been simplified right down to the stage where the systems offered by both ICI and Baxenden come in two containers. When these liquid components are mixed, a reaction ensues during which time a lot of heat is generated and gas is liberated which blows up the mixture into a foam which subsequently sets hard. The only basic difference between dispensing and spraying equipment for applying these is that the nozzles and air supplies are arranged differently.

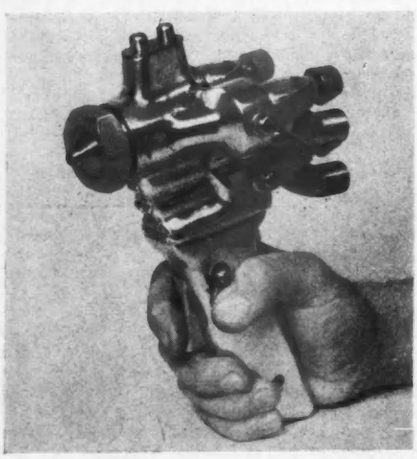
It is worth knowing just one or two key ideas about how these foam systems work if you want to make sense of the variations in foam properties and the precautions which must be taken in spraying them. For instance, you may end up with a conductivity value of 0·23 Btu per sq. ft-hr-deg. F per in or one of 0·14 units—which is virtually halved. When thinking in terms of thermal insulation, this is very important. Also, with one system you may be advised to arrange for spraying personnel to have breathing apparatus, while this may not be needed with the other. These stem from the nature of one half of the chemical and from the type of gas formed in the pores of the foam.



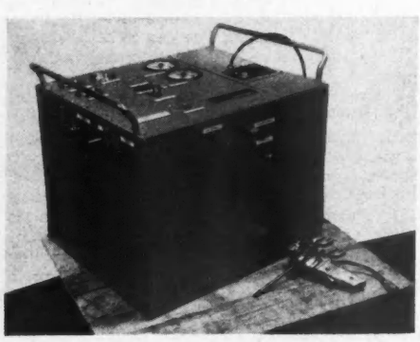
Aerograph-DeVilbiss spray equipment; (above) being used for covering pipe with insulation.

ICI started off with their so-called isocyanate foams in which carbon dioxide was created to blow up the foam when the two components were mixed. For this type—and the carbon dioxide gives it the higher conductivity value of 0·23 units—there is no need for breathing equipment with the right formulation. Also, since the reaction depends on having water present, it doesn't hurt to spray these foams on to reasonably damp surfaces. It's not quite the same with the Baxenden version. As presently formulated, the gas which blows up the foam comes from Freon 11 which is evaporated by the heat of reaction as this rises above Freon's boiling point of 25° C. This gas gives the lower and better conductivities of 0·14 units, but the mixture incorporates a component which can irritate the eyes unless ventilation or breathing apparatus if provided. That is what you can see in the illustration of Aerograph equipment. Also Baxenden say the reaction is upset if water is present such as on a metal surface.

Thus, Aerograph and Baxenden place their faith in Freon-blown foams. ICI have up till now mainly used the carbon dioxide-blown process, but it is recently on record that this firm are also attracted to the Freon-blown process; Viking Engineering have in fact supplied five ICI-designed dispensers to BMC at Longbridge and three dispensers to BMC at Cowley for injecting Freon-blown urethane foams under the sills of the Baby Austin and Mini Minor for moisture sealing. ICI also admit that blowing with Freon is the cheaper process.



Latest design of metering equipment made by Viking Engineering for use with ICI designed gun.



Aerograph quote material costs at about 6*s* 6*d* to 9*s* a cu. ft of expanded foam at a density of 1·1 to 1·6 lb per cu. ft, respectively, derived from liquids which, used in the right proportions, cost a total of about 6*s* a lb. Their present equipment costs under £400 with 5 gallon tanks assuming a supply of compressed air at about 100 lb per sq. in; with ICI, the price a little while ago was said to be nearer £750.

The basis for simplification in the Aerograph equipment is that when spraying Freon-blown foams, some variation in proportions of the components as supplied by Baxenden can be tolerated. Thus they have been able to eliminate the complex metering equipment which ICI sensibly suggest should be used for large-scale dispensing plant but which ICI also recommend for feeding the spray gun as illustrated.

Aerograph have drawn their experience from their paint equipment. Metering of the components is arranged by forcing them at preset pressures through the two orifices in the gun itself. Thus they use one of their air pressure transformers (a pressure reducer and stabiliser) to pressurise one liquid container directly, and the other liquid container via a pressure-reducing valve. They find that even with fluctuating temperatures (and they've gone down to 10° C) the viscosities of the Baxenden formulation components are so nearly similar that the proportions of each in the final mix is constant.

It is only necessary to occasionally brush the nozzle with acetone so that the orifices are kept from clogging up. At the end of the day, the two components can be openly poured back into other containers and the system flushed through with acetone.

It should be noted that the foams used for spraying are normally rigid ones. Aerograph, for example, quote a compressive yield strength of 15 lb per sq. in. Adhesion will normally be greater than the strength of the foams for all types. In long term tests, it has been shown that Freon stays inside the foam indefinitely and conductivity doesn't rise above 0·16 units—which is still superior to the figure of 0·23 for carbon dioxide-blown foams.

ICI Limited, Dyestuffs Division, Hexagon House, Blackley, Manchester 9.
Viking Engineering Company Limited, Buckingham Street, Salford 5, Manchester.
Aerograph-DeVilbiss Company Limited, 47 Holborn Viaduct, London, EC1.
Baxenden Chemical Company Limited, 83 Euston Road, London, NW1.

Japanese Tanker for Refrigerated LPG

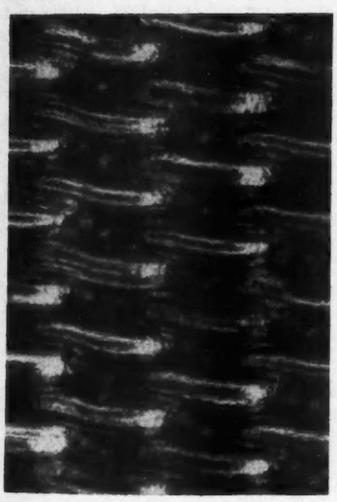
One of the most important shipyards in Japan, Mitsubishi Nippon Heavy Industries (Yokohama), is building a refrigerated LPG tanker for the Bridgestone Liquefied Petroleum Gas Company of Tokyo. The vessel will have a capacity of 180,000 barrels, equivalent to about 17,000 tons of refrigerated LPG at about − 40° F, and a service speed of 16 knots.

This ship has been designed by Conch International Methane for the owners, and the special low temperature features are based on Conch patents under a licence agreement with Bridgestone Liquefied Petroleum Gas Company, which was validated by the Japanese Government in May, 1960. It will be recalled that the world's first liquid methane carrier, the Methane Pioneer, which made seven completely successful deliveries from the US Gulf Coast to Canvey Island, England, was designed and developed by Conch, and the Bridgestone tanker will incorporate much of this know-how and experience.

The Bridgestone tanker will be the first large-scale commercial ship to carry LPG at essentially atmospheric pressure. It is scheduled for completion early in 1962. Supplies of refrigerated LPG are being obtained from Kuwait. In Japan the LPG will be distributed by Bridgestone for industrial and domestic use. *Conch Methane Services Limited, Villiers House, Strand, London, WC2.*

Wire Filter Stops 10 Micron Particles

A very fine filter medium primarily developed for precision hydraulic and fuel systems in the aircraft and rocket industry is now being woven commercially in this country by United Wire Works. Micro-Hollander stainless steel wirecloth with a 325/2,300 mesh is said by the makers to possess a high degree of uniformity and retains particles of the order of 10 microns (0·00039 in) compared with 35·6 microns in



400/400 mesh.

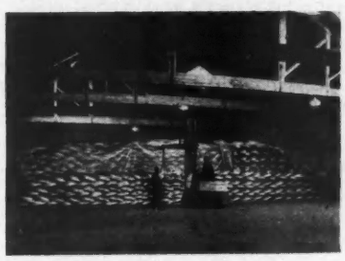
Micro-Hollander is woven with 0·0010 in diameter wire, and a square inch of cloth comprises 325 warp wires running lengthwise, interwoven with 2,300 tightly knocked-up weft wires. Being twill woven the individual wires in one direction pass alternately over two and under the next two cross wires in succession. The illustration shows the structure magnified 225 times. This provides 747,500 openings per sq. in. Unlike square woven wirecloths, the openings in this Hollander specification are not apertures in the true sense of the word. Though absolutely uniform in critical dimension, they follow a sinuous path through the thickness of the cloth, do not permit transmission of light, and permeation of liquids is only possible under pressure.

The material is said to offer many advantages over other filter media, not least being the accuracy and regularity of limiting opening size. Its robust structure permits high operating pressures, while being stainless steel, it has excellent corrosion resisting properties and its application can cover a wide temperature range. *United Wire Works Limited, Granton, Edinburgh 5.*

Dehumidified Bag Protects Bridge Wire

Dorman Long (Steel), who are making the suspension cables for the new Firth of Forth bridge in Scotland, were faced with the problem of preserving more than 7,000 tons of galvanised high-tensile steel wire worth about £600,000 from a steelworks atmosphere before shipment. They solved this by enclosing the stacked wire coils inside sealed polyethylene " bags," from which the moisture was extracted by dehumidifying units.

The wire has been built up into storage over a period of fourteen months before being shipped to the bridge. It is being stacked in a large disused slag mill with a bay open to atmosphere during the day. The building is in the centre of Middlesbrough, focal point for polluted



air contamination.

During experiments, a stack of wire weighing 52 tons and occupying 1,600 cu. ft was erected and sealed off as far as possible from atmosphere with an undersheet of sisal kraft paper and an oversheet of polyethylene. The sheets were weighted together at the floor to form a seal against massive air change. Inside the bag was placed a Westair 150T dehumidifier. In the first two days about 1½ gallons of water were extracted. Hygrometers positioned at various points in the bag showed a steady uniform drop in humidity compared with outside conditions. Over a week, humidity conditions settled down to dry, and extracted moisture reduced to a steady 2 pints a day.

When extended to the bulk of the wire, both oversheets and undersheets of polyethylene were used, welded together at the ends by an electric hot-iron tool around lots of 150 tons of wire each occupying 3,600 cu. ft.

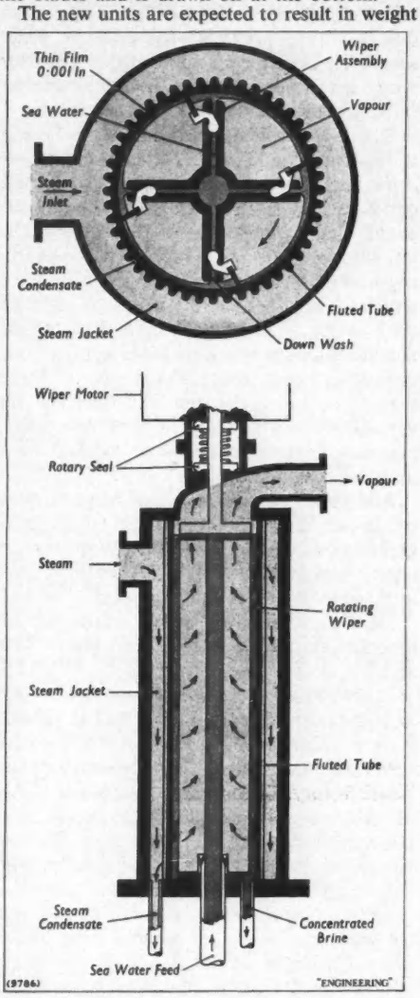
Seawater Evaporator Has Wipers and Flutes

An economical method of salt water purification was announced by US General Electric recently upon completion of initial tests. The system has several novel features and GE think the principles could be applied to many other kinds of heat exchangers. Water has been obtained from seawater with as little as one part per million of salt.

In the evaporator, a wiper system distributes a 0·001 in layer of salt water on the inner walls of a 50 in long vertical copper tube of 6 in diameter and 0·05 in wall thickness. This is surrounded by a second cylinder serving as a steam jacket. The exterior of the copper tube is fluted, so that heating steam condensate runs down the grooves. This leaves the crests dry; a pressure gradient is produced by surface tension in the plane at right-angles to the axis of the tube, resulting in a heat transfer coefficient as high as 40,000 Btu per sq. ft-hr-deg F temperature differential. This is said to be four times as large as those in conventional systems.

The vertical wiper system rotates at 200 rpm, and is concentric with the copper tube. Salt water feed enters the unit through the centre of the base and flows upward through the hollow wiper shaft. At the top of the shaft a distributor discharges the water on the inside walls just in advance of the wiper blades, so that as water flows down the hot walls it is spread into a thin film. The vapour so formed is drawn off the top of the tube; the brine flows down ahead of the blades and is drawn off at the bottom.

The new units are expected to result in weight



and space savings as much as 40 and 60 per cent respectively compared with conventional distillation plants. They extract 42 lb of fresh water from each hundredweight of seawater, and can also be used for brackish and polluted water. Systems producing 1,000 to a million gallons daily are already being considered.

The process was developed especially for marine use under contracts with the US Navy and the Office of Saline Water of the US Department of the Interior. Advantages are claimed for marine application including unimpaired operation in high seas. The thin film units are also self-cleaning, which inhibits scale formation. Pumping requirements are also smaller since less water is circulated.

Prototype thin film units have had about 1,000 hr of tests, including a continuous 130 hr run at the GE laboratory in Burlington, Vermont. Some 50 combinations of wiper design and condensing surface conditions have been tested. Tests were made at pressure levels corresponding to saturation temperatures from 120 to 212° F. *International General Electric Company, Inc., 570 Lexington Avenue, New York 27, NY, USA.*

Plain Words

By Capricorn

As we become less able to test the evidence of experts, we are forced to take more and more on trust. Even Her Majesty's Ministers are at liberty to quote the views—misinterpreted no doubt—of specialists, who need not be produced to back them up. Soon only the " appropriate authority " will be allowed to speak his mind, and in certain quarters this privilege has already been secured. The expert is enthroned. I wonder where he's leading us—he the blinkered and ourselves the blind.

But there have been times when I have thought how much better a solution to our economic and technical problems we would get if we left it all to experts. If only we could find some way of harnessing the knowledge and ability of those who constantly acquire more and more expertise about less and less, we ought to have a sum total of very impressive experience and detached analytical ability which we could apply to our difficulties—even the political ones. There would be no intruding self-interest, no variable human factor to disturb our calculations. Everything might be reduced to a series of equations.

And then I wonder. Would the scientists be so detached? Who would stop them bickering like members of craft unions at encroachments on each other's spheres of influence? Who should adjudicate among them if they could not agree? Someone as ignorant as me? Someone who knows less and less about more and more?

What started me off on this at all was the announcement recently that in Russia no one is now allowed to lecture or write about space subjects unless their credentials are " satisfactory." They have had a late wave of the flying saucer and little green men craze in the Soviet Union, and higher authority in that monolithic state has decided that the craze has gone far enough. So only those with good credentials will be allowed to speculate about the character of outer space before an audience.

Galileo didn't see little green men in his day but he asserted that the world was round when those with credentials had a vested interest in making sure that everyone believed it to be flat. Now in the 20th Century the Russians are on the verge of carrying their particular brand of orthodoxy into space—and be it noted the claims of censorship are going ahead of the first astronaut.

I have no taste—nor flair—for lecturing on flying saucers, but I do think there is just a chance the amateur may have something useful to contribute. The specialist may wish to make his authority unassailable, but if we leave him undisputed master in his own territory, the uninformed but liberal speculation that feeds even his own imagination will atrophy and die.

Of course, I'm a specialist myself, and very jealous of my expertise. Let no one dare to tell the writer of this column where to use a colon.

Letters to the Editor

The First Two Years After Graduation

Sir, Your article entitled " The First Two Years After Graduation " (Engng., 17 Mar. '61, p. 382) is a timely and welcome comment on a subject currently liable to considerable criticism, not only from graduates who appreciate most the size of the immediate financial award, but among engineers and educationalists who may not all agree that there are advantages in the variability in the training available to engineers.

When one analyses the lives of the great engineers two significant facts are worth recording. The fathers of great engineers were often either comparatively poor or comparatively rich men. The sons of the poor men—the Telfords, the Stephensons and the Edisons—had at an early age to work with their hands. The sons of the rich men—the Riabouchinskys, the Charles Parsons and the Ricardos—were provided at an early age with the facilities to encourage laboratory or workshop interests involving manual work, which presumably did something to their brains—provided the necessary motivation, gave some form of appreciation of three dimensions, or created a desire to make things.

During many years as a REME officer with the opportunity of observing young graduate engineers, and in my present work as education officer of the Institution of Mechanical Engineers, some ideas on this subject have matured to a point where it now seems that the creative engineer is the man who had good early practical training in some form or another. One of the advantages of either the " thick " or the " thin " sandwich scheme of training is that the embryo engineer is more easily accepted on the shop floor before being weighed down by the title " graduate." It is unfortunately only too common to hear graduate apprentices (sometimes now said to be student princes rather than student apprentices) talk of practical training as a " waste of time."

Some, already self-persuaded that the world is their oyster, possibly do waste their time by failing to realise that however repetitive the work, even the best machine cannot for ever retain components within the control limits, that there is variability in every operation, and that there can be real interest for the graduate trainee in analysing the nature and discovering the cause of undesirable variations in dimension or quality of product. In every foundry, pattern shop, press shop or even precision machine shop there are problems to be studied and solved, as well as processes and techniques to be learned; and there is always human nature to be understood.

If, instead of swopping stories in the canteen corner, these graduates could be encouraged to apply their trained minds to recognising some of the problems in the department (did that aluminium impeller fail because it was mounted on a bronze shaft? Why should it be necessary to " grind back " teeth gear after hardening and so start hair cracks and possible future fatigue failure? Is there not a better way of making these shells without wasting so much material in swarf? Surely there are easier ways of recessing the mica on that commutator? Do men really like standing in a queue for their pay envelopes?). If as he works in each department the graduate apprentice can be encouraged to ask himself the standard work study questions, *why*, *what*, *where*, *when*, *who*, *how*, then the firm's suggestion boxes should bulge with better methods, the graduate may have a sense of achievement, the firm's costs may even be reduced and the only man to suffer is the secretary of the suggestions committee, who can never catch up with his task.

Every firm employing a graduate apprentice has a consultant on its staff, and provided he is not deliberately taken away from his practical training and falsely forced into that role, he can not only learn a great deal himself, but he can be an immediate asset to the company, for his opportunity of studying the detailed problems of manufacture will never again be so close, mentally and physically, to the skilled man on the shop floor.

Yours faithfully,
L. A. Work.

Woking, Surrey.
21 March, 1961.

Events in Advance

Fluid Sealing Conference

Increasing working pressures, operating speeds and fluid temperatures are now being encountered in many branches of engineering and their existence has emphasised the importance of satisfactory fluid-sealing devices of all kinds. As a result, a large amount of effort is being devoted to the various research problems in this field.

Much valuable work is now being undertaken, but, as the subject is a relatively new one for scientific research, there is a lack of coordination, on both the national and international levels, in respect of what is being done and to the results that are being obtained. In order to remedy this position and to provide a common meeting ground for those interested in the problems which have arisen, the British Hydromechanics Research Association have arranged an international conference on fluid sealing and this event will take place at Ashford, Kent, from 17 to 19 April.

The conference has been divided into eight technical sessions, at which some 30 papers will be presented for discussion. In addition to the British contributions, there will be nine papers from the United States, two from Japan, and one each from Denmark and Sweden.

Subjects covered will include liquid seals for rotating and reciprocal shafts, seals for static applications, the sealing of gases, theoretical and experimental work on radial face or mechanical seals, and sealing materials, including rubbers, carbons and refractory types for high-speed applications. The concluding sessions will be devoted to special environmental conditions, such as high temperatures, long-term space exposure, hazardous fluids and abrasive liquids.

Written contributions may be submitted to the Association after the conference, provided that they are received before 31 May next.

Accommodation at Ashford is limited and all the 250 places available have been allotted, but copies of the papers are obtainable price six guineas a set or 6s for each copy. Further details respecting the conference and copies of the papers are obtainable from the British Hydromechanics Research Association, South Road, Temple Fields, Harlow, Essex.

Exhibitions and Conferences

Engineering Display, 14th.—Tues., 17 Oct., to Thurs., 19 Oct., at the Royal Horticultural Society's New Hall, Greycoat Street, London, SW1. Organised by the Engineering Industries Association, 9 Seymour Street, Portman Square, London W1. Tel. WELbeck 2241.

Motor Show, 46th International.—Wed., 18 Oct., to Sat., 28 Oct., at Earls Court, London, SW5. Organised by the Society of Motor Manufacturers and Traders, Forbes House, Halkin Street, London, SW1. Tel. BELgravia 6611.

Iron and Steel Institute, Special Meeting in Canada and the United States.—Thurs., 19 Oct., to Tues., 7 Nov. Offices of the Institute: 4 Grosvenor Gardens, London, SW1. Tel. SLOane 0061. (Provisional arrangements.)

Reactor Experiments and Tests, Symposium.—Mon., 23 Oct., to Fri., 27 Oct. Apply to the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria. (*Venue not yet arranged.*)

Dairy Show, 75th Annual.—Tues., 24 Oct., to Fri., 27 Oct., at Olympia, London, W14. Organised by the British Dairy Farmers' Association,

17 Devonshire Street, London, W1. Tel. LANgham 6903.

Saigon International Trade Fair.—Thurs., 26 Oct., to Sat., 25 Nov., in Saigon, South Vietnam. Organised by the Saigon Chamber of Commerce, Tu-do Street, Saigon, South Vietnam. In the United Kingdom, apply to the Economic Department, Embassy of Vietnam, 12 Victoria Road, London, W8. Tel. WEStern 3765.

Engineering in Plastics, Conference.—Mon., 30 Oct., and Wed., 1 Nov., at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Organised by the Plastics Institute, 6 Mandeville Place, London, W1. Tel. WELbeck 5439.

Fire Prevention Week, National.—Mon., 30 Oct., to Sat., 4 Nov. Organised by the Fire Protection Association, 31-45 Gresham Street, London, EC2 (Tel. MONarch 7412) and the Royal Society for the Prevention of Accidents, 52 Grosvenor Gardens, London, SW1. Tel. SLOane 2246.

Educational Problems of Nuclear Energy, Regional Seminar.—In November, at San Carlos de Bariloche, Argentina. Apply to the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria.

Indian Industries Fair, Second.—Sat., 4 Nov., to Thurs., 21 Dec., in Delhi. There will be an organised British display. Inquiries in the United Kingdom should be addressed to the Export Publicity and Fairs Branch, Board of Trade, Horse Guards Avenue, London, SW1. Tel. TRAfalgar 8855, ext. 2853.

Non-Destructive Testing in Electrical Engineering, Conference on.—Wed., 8 Nov., to Fri., 10 Nov., at the headquarters of the Institution of Electrical Engineers. Theme: "How Best May the Electrical Engineer Test the Quality and Endurance of His Materials and Structures." Organised by the Measurement and Control Section of the Institution, in association with the British National Committee on Non-Destructive Testing. Apply to the secretary, the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Scottish Motor Show, 43rd.—Fri., 10 Nov., to Sat., 18 Nov., at Kelvin Hall, Glasgow. Organised by the Scottish Motor Trades Association Ltd., 3 Palmerston Place, Edinburgh 12. Tel. Edinburgh-Caledonian 3643.

Engineering Materials and Design Exhibition, Second.—Mon., 13 Nov., to Sat., 18 Nov., at Earls Court, London, SW5. Organised by Industrial and Trade Exhibitions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Electronic Counting Techniques": symposium, consisting of a series of papers on counters employing trochatrons transistors and magnetic film techniques. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 26 April, 6 p.m.*

CHELTENHAM
"The Mesa Transistor and Its High-Frequency Applications," by D. H. Mehrtens. Annual General Meeting. South Midlands Section. North Gloucestershire Technical College, Cheltenham. Fri., 21 April, 7 p.m.

LIVERPOOL
"The History of Radio," by G. R. M. Garratt. Merseyside Section. Adelphi Hotel, Liverpool. Wed., 19 April, 7 p.m.

SOUTHAMPTON
"The Development of an Ammonia Maser Oscillator as a Frequency Standard," by A. Mitchell. Southern Section. Lanchester Buildings, The University, Southampton. Wed., 19 April, 7 p.m.

Building Centre

LONDON
Film: "Taking Stock," exhibited by John Laing and Son, Ltd. Being a survey of the company's various construction projects in the United Kingdom and overseas during the past ten years. Wed., 26 April, 12.45 p.m.

Chemical Society

HULL
"Electronic Spin Resonance of Some Inorganic Crystals," by Professor H. C. Longuet-Higgins. Hull Branch. Department of Chemistry. The University, Hull. Thurs., 4 May, 5 p.m.

Illuminating Engineering Society

MANCHESTER
Annual General Meeting and Open Discussion, to be introduced by W. Carlton, G. Mawson and J. E. Tonge. Manchester Centre. Offices of the North Western Electricity Board, Town Hall Extension, Manchester 2. Thurs., 13 April, 6 p.m.

Institute of Marine Engineers

LONDON
Presidential Address, by Viscount Simon, C.M.G. To be followed by the Annual General Meeting. Tues., 25 April, 5.30 p.m.*

Institute of Road Transport Engineers

LONDON
"Automotive Transmission Lubrication," by W. A. Patrick. Metropolitan Area. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 20 April, 6.30 p.m.

LEEDS
Annual General Meeting. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 20 April, 7.30 p.m.

NOTTINGHAM
Annual General Meeting. East Midlands Centre. Mechanics' Institute, Nottingham. Wed., 19 April, 7.30 p.m.

Institution of Agricultural Engineers

LONDON
Annual General Meeting, at 10.30 a.m. "Traffic Requirements for International Agricultural Engineering Standards," by C. H. Hull, at 11.30 a.m. Forum on "Why Plough?" with J. Cass, G. P. Harding and J. C. Hawkins as the principal speakers, at 2.30 p.m. "Technological Considerations of the Uses of Metals in Agricultural Engineering," by Dr. I. G. Slater, at 4.15 p.m. Dinner at 7 for 7.30 p.m. At the Piccadilly Hotel, W1. Tues., 25 April.

Institution of Chemical Engineers

CHESTER
"Some Corrosion Problems in the Chemical Industry," by D. Bennion. North Western Branch. Grosvenor Museum, Chester. Wed., 19 April, 7.30 p.m.

Institution of Civil Engineers

LONDON
"The Inner Ring Road, Birmingham," by Sir Herbert Manzoni. Tues., 25 April, 5.30 p.m.*
"Safety Aspects of Motorway Design," to be introduced by W. F. Adams. Traffic Engineering Study Group. Thurs., 27 April, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Development of City Distribution Systems," by G. W. Green, London Graduate and Student Section. Mon., 24 April, 6.30 p.m.*
"Simulation of Intelligence," by Professor D. M. Mackay. Measurement and Control Section. Tues., 25 April, 5.30 p.m.*
"Data Transmission," by R. H. Franklin and J. Rhodes. Electronics and Communications Section. Wed., 26 April, 5.30 p.m.*
"Medical Electronics," by Professor R. F. Woolmer. Fifty-second Kelvin Lecture. Thurs., 27 April, 5.30 p.m.*

BIRMINGHAM
Open Discussion Meeting. South Midland Education Discussion Circle. College of Technology, Gosta Green, Birmingham. Fri., 28 April, 6 p.m.

FARNBOROUGH
"The Future of 'Electrics' and 'Electronics' in Aircraft and Guided Missiles," by Viscount Caldecote. Southern Centre, Farnborough Technical College, Farnborough. Tues., 18 April, 6.15 p.m.

GLASGOW
"Measured and Electrical Model Characteristics of Buildings Heated by Floor Thermal Storage," by E. D. Taylor, B. Berger and G. Blaylock. South West Scotland Subcentre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 12 April, 6 p.m.

SCUNTHORPE
"Silicon Power Rectifiers," by A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams. Sheffield Subcentre. North Lindsey Technical College, Scunthorpe. Wed., 19 April, 6.30 p.m.

Institution of Electronics

BIRMINGHAM
"Long-Distance Communication by Circular Wave Guide," by F. J. D. Taylor. Birmingham Branch. New College of Technology, Gosta Green, Birmingham 4. Fri., 21 April, 7 p.m.

Institution of Engineering Inspection

BIRMINGHAM
Exhibition of Industrial Films. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Wed., 19 April, 6.30 p.m.

Institution of Heating and Ventilating Engineers

LIVERPOOL
Annual General Meeting. Liverpool Branch. Exchange Hotel, Titheburn Street, Liverpool. Fri., 21 April, 6.30 p.m.

NEWCASTLE UPON TYNE
Annual General Meeting. North East Coast Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 24 April, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Undergraduate Project Work in Full-Time and Sandwich Courses in Mechanical Engineering": Discussion, to be opened by Dr. R. W. Steed. Education and Training Group. Wed., 19 April, 6 p.m.*

BELFAST
"Engineering Dimensional Metrology as an Aid to Engineering Production," by Professor J. Loxham. Northern Ireland Branch. Central Hall, College of Technology, Belfast. Tues., 25 April, 6.45 p.m.*

LEEDS
"Influence of Rate of Strain Hardening in Machining," by P. L. B. Oxley," A. G. Humphries and Larizadeh; and "Some Physical Aspects of Built-up Nose Formation," by W. B. Heginbotham and S. L. Gogia. Ordinary Meeting. Chemistry Lecture Theatre, The University, Leeds. Tues., 18 April, 6.30 p.m.

SWANSEA
Selected graduates' papers. South Wales Branch. Offices of the South Wales Electricity Board, Kingsway, Swansea. Tues., 18 April, 6 p.m.

Institution of Plant Engineers

CARDIFF
"Fuel Efficiency," by W. Short. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 25 April, 7.30 p.m.

LEEDS
"Introduction of Planned Maintenance Systems," by A. F. Stedman. West and East Yorkshire Branch. Houldsworth School of Applied Science, The University, Leeds. Mon., 24 April, 7.30 p.m.

Institution of Production Engineers

LONDON
"High-Speed Cinematography in Production," by J. Hadland. Royal Commonwealth Society, Craven Street, Strand, WC2. Thurs., 20 April, 7 p.m.

BIRMINGHAM
"International Competition in Machine Tool Design and Production," by Robert Asquith. Birmingham Section: Midland Hotel, Birmingham. Wed., 19 April, 7 p.m.

WOLVERHAMPTON
"Marketing Research and the Follow-up of Sales. Techniques," by A. H. J. Hall, assisted by J. H. Kassell. Wolverhampton Graduate Section. Wolverhampton and Staffordshire College of Technology, Wulfruna Street, Wolverhampton. Wed., 19 April, 7 p.m.

Junior Institution of Engineers

LONDON
"Greece and Oberammergau," by G. V. Rickards. Fri., 21 April, 7 p.m.*

Liverpool Metallurgical Society

LIVERPOOL
"Continuous Casting of Aluminium Alloys," by Dr. W. M. Doyle. Annual General Meeting. Department of Metallurgy. The University, Liverpool. Thurs., 20 April, 7 p.m.

Royal Aeronautical Society

LONDON
"Air Traffic Control." All-Day Symposium. Astronautics and Guided Flight Section. Thurs., 20 April.
"On the Origin, Structure and Growth of Vortex Separations," by E. C. Maskell. Tues., 25 April, 7 p.m.

Royal Institution of Chartered Surveyors

LONDON
"The Conflict Between Capital Cost and Running Costs—The Use of Cost Prediction as a Guide to Planning and Design," by P. A. Stone. Quantity Surveyors' General Meeting. Wed., 19 April, 6 p.m. (Admission will be by ticket.)

Royal Meteorological Society

LONDON
Annual General Meeting and Presidential Address. Wed., 19 April, 5 p.m.*

Royal Society of Arts

LONDON
"Training of Scientists and Engineers for Industry," by Sir John Cockcroft. Wed., 26 April, 2.30 p.m.

Society of Instrument Technology

LONDON
"Electronic Telephone Exchanges," by T. H. Flowers, at 7 p.m. Preceded by the Annual General Meeting, at 6.15 p.m. Data Processing Section. Manson House, 26 Portland Place, W1. Wed., 19 April.

BRISTOL
Annual General Meeting and Film Evening. Bristol Section. Department of Physics, University of Bristol, The Royal Fort, Bristol 8. Mon., 17 April, 7.30 p.m.

CHELTENHAM
"Instrumentation Developments in the Petroleum Industry": Presidential Address, by G. C. Eltenton. Cheltenham Section. Belle Vue Hotel, Cheltenham. Wed., 19 April, 7.30 p.m.

LOUGHBOROUGH
Annual General Meeting and Presidential Address. East Midland Section. College of Further Education, Greenclose Lane, Loughborough. Thurs., 20 April, 7.15 p.m.*

South Wales Institute of Engineers

CARDIFF
"Rope Attachments," by E. Ivor David. Thurs., 20 April, 6 p.m.

Southampton Metallurgical Society

SOUTHAMPTON
"Development of Cast Metals," by Dr. H. T. Angus. Southampton Technical College, Southampton. Wed., 26 April, 7.15 p.m.

West of England Metallurgical Society

BRISTOL
"Temperature Measurement," by J. A. Hall. College of Technology, Ashley Down, Bristol 7. Fri., 21 April, 7.30 p.m.

Women's Engineering Society

MANCHESTER
"Paints in Industry": Discussion. Manchester Branch. Manchester Society of Chartered Accountants, 46 Fountain Street, Manchester 2. Wed., 19 April, 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Building Centre, 26 Store Street, London, WC1. (MUSeum 5400)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London, SW7. (KENsington 3744)
Institution of Agricultural Engineers, 6 Queen Square, London, WC1. (TERminus 0140)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgrave 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661)
Institution of Engineering Inspection, 616 Grand Buildings, Trafalgar Square, London, WC2. (WHItehall 0818)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road, St. Helens, Lancs. (St. Helens 5879)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution of Chartered Surveyors, 12 Great George Street, London, SW1. (WHItehall 5322)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)
Southampton Metallurgical Society. Apply to Mr. S. W. Hallwood, Folland Aircraft Ltd., King's Avenue, Hamble, Hants.
West of England Metallurgical Society. Apply to Mr. F. C. Thornton, College of Technology, Bristol.
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

Engineering's Contribution to the Future

In a world of great material progress, the engineer—The Aristocrat of the Twentieth Century—must find time to study the mistakes made in the affairs of mankind.

THE professional engineer is not as hard worked as he thinks he is. Or, at least, he ought not to think of himself as working all day and half the night, for five or six days a week.

Winding up the one-day conference on The Professional Engineer—His Employment and Development, organised in London last week by the Engineers' Guild, Sir Hugh Beaver, President of the Guild, with a lifetime's work in a multitude of causes behind him, roundly declared: "I do not believe for a moment that engineers are so hard worked that they cannot contribute to the public world, to the public life of which they are part."

The role the engineer plays in the civic life of his community and of the nation had been examined by speakers from the floor, castigated as inadequate by at least one speaker, and dwelt on in further detail by Sir Hugh Beaver.

Engineers, he found, were inward looking. They were not prepared to feel that they were ultimately responsible as citizens of their country. They were not sufficiently outward looking.

Before Sir Hugh, one lone voice from the ranks of technical directors, chief and senior engineers, general managers, consultants, training officers and others on the floor, had spoken up to declare that at any rate one practising engineer, himself, was serving his local authority as a Councillor.

The apparent agreement on the small part played by engineers in public life contrasted with the vigorous appeal of Lord Chandos, former Colonial Secretary and now chairman of Associated Electrical Industries. Himself descended from the long and distinguished Lyttelton line, Lord Chandos, in his paper *The Engineer in Society*, reminded the members of the profession of their duties as the "aristocrats of the 20th century."

Just as the great land owners of the past had brought skill in agriculture to the improvement of material standards of living, so the engineer now held out a future in which the word starvation should become obsolete, the word underdeveloped an anachronism, the term unemployment would cease to be used and the word leisure substituted.

WHAT ENGINEERS DO

But Lord Chandos went on to a gloomier picture, presenting sobering propositions to the engineers in their role as responsible aristocrats. Overpopulation, with the numbers of people born outstripping the increases in the production of wealth, the very little progress made in human relations, the struggles going on around the world—the AEI chairman presented all these as problems which engineers, as among the most highly educated people in the country, should be devoting a substantial part of their time and leisure to thinking about.

The conference heard its first paper from Mr. D. J. Mann, director and head of Unilever's personnel division. Mr. Mann drew on the practice of his own company for a guide as to what constituted a professional engineer and what makes up the technician. His paper was *The Engineer and the Technician.*

Within Unilever, Mr. Mann reported, the professional engineer is accepted as competent by virtue of his education, training and experience to originate scientific methods in the analysis and solution of engineering problems. His work requires original thought and judgment and an ability to supervise and instruct others. He ought also to be capable of contributing to the development of engineering science.

Technicians were, in general, people applying proven techniques, or techniques prescribed by professional engineers. Education, training and experience are required to an extent sufficient to enable him to understand the reasons and purposes of a task for which he is responsible.

Leaving definition behind, Mr. Mann set out to answer three questions:

> To what extent does industry want professional engineers?
>
> What level of work is the professional engineer required to do and what is he in fact doing?
>
> Is the proclaimed shortage of engineers due in any measure to a failure to reserve professional engineers for duties needing professional qualifications, and to a tendency to allocate work to them which could satisfactorily be undertaken by technicians.

Within industry Mr. Mann identified the small, medium and large organisations, some with research, design and development problems, others with activities for whom engineering was the handmaiden, providing services to meet production programmes, make modifications, prepare drawings and estimates and generally assist management. While the process industries were of this style they also needed professional engineers of the highest quality to design, develop and instruct on what is required.

Considering the proper employment of professional engineers and technicians, Mr. Mann observed that they tended to become confused. There were considerable areas of common interest to the higher grade technician and the professional engineer.

A DIFFERENCE OF DEGREE

From this Mr. Mann passed easily into questions of training. In the past much of a professional engineer's training has lain along the same route as that of the man who stopped short (voluntarily or not) of professional qualification. Bearing this in mind, were they such different people? Were examination marks of 49 per cent and 51 per cent sufficiently discriminating to make it possible to say, this one is to be a technician and that one an engineer?

This is a situation being overtaken by change. In the early 1950's more than half the members of the major professional engineering institutions had qualified through part-time courses at technical colleges. This was not now merely difficult; in some cases it was almost impossible to qualify by this route. Future professional engineers will have qualified after full-time or sandwich courses of university first degree level.

In striving to get the best use of highly qualified scientific or technological manpower, Mr. Mann warned against woolly minded thinking leading to the "ivory tower concept," with the professional engineer working on altogether higher and different level from the technician. The best results might come from vertical rather than horizontal divisions in an organisation, so that a team of workers would include scientists, technologists, technicians and craftsmen.

Wider terms of reference for such integrated vertical teams would lead to the disappearance of the "development gap" between research, design and application. It would lead in the same direction too, if those concerned thought more of results in terms of company production and sales, disregarding problems of status. The greatest satisfaction might be achieved when design teams moved further towards execution in following the project through until teething troubles are almost entirely over and production is fully under way.

After these qualifications, Mr. Mann plumped for this description of the level of work of the professional engineer. His level is—"Research, up to date technical information, and research design, development, and effective cooperation with the academics and professionals in other scientific and technological fields. He should also be much concerned with training and with management and be able to appreciate the need for priorities and to recognise the validity of claims other than his own for shares of the financial cake."

Mr. Mann drew this effective picture of the narrowly specialising engineer—"The man who remains a narrow specialist is in the role of a single tool on a capstan lathe—useful for a narrow range of functions but for very little else."

On the question of the fullest use of the professional engineer, Mr. Mann, not surprisingly for a Unilever man, evidently believes that in this the big companies are *per se* efficient. For he said: "My own guess is that since it is in general the larger firms which employ most professional engineers there is not much misuse of their abilities and qualifications." Among the smaller companies it would be silly for the professional engineer to sit with folded arms while a technician dealt with the work deemed to be below professional level. In some small companies the engineer would be a technician doing a certain amount of the work of a professional engineer and thereby conserving, rather than the reverse, the scarce resources of professional engineers.

Among his conclusions, Mr. Mann asserted that quite a large number of technicians employed in engineering work were distinguishable from professional engineers only by the fact that they had failed to pass the examination of the professional Institution. There was probably little, if any, difference in ability on the job between those who just pass and those who just fail.

From the increasing importance in industry of integrated team work between engineers and technicians following through development stages and the pilot plant phase into production, Mr. Mann concluded that the managerial ability of the professional engineer "becomes of great importance."

To the subject of managerial ability, or attainment of managerial position, the conference devoted much of its attention both in the period for questions after the opening paper, and later, after *The Engineer in Management*, given by a member of the Central Electricity Generating Board.

GRADUATES IN PRODUCTION

Mr. B. E. A. Vigers, deputy chairman and technical director of Laporte Industries, declared that in the process industries the professional engineer was less of a specialist and more of a general practitioner. Much of the engineer's value lay in his ability to overlook the whole field of engineering. He had the merit of being able to do a certain amount of cross breeding of ideas.

The need to get more professional engineers into the production end of the industrial process was strongly emphasised by Mr. Frank Nixon, a chief quality engineer of Rolls-Royce. There was quite a wastage of engineers in contemporary industry. Mr. Nixon had found that many engineers coming into industry in recent years had by now become happily esconced in their ivory towers and had no interest in coming to the manufacturing side. There must be a better balance than at present in the proportion of professional engineers on research and development and on the manufacturing side. The present situation was not only the fault of the universities but also of industry.

Steps towards a scheme in the civil engineering industry for training towards a qualification recognising technician's status were described by Mr. P. W. E. Holloway, chairman and managing director of Holloway Brothers (London), who is also the chairman of the training committee of the Federation of Civil Engineering Contractors.

Holders of the technician's qualification would be able to take charge of the smaller

grade of civil engineering contract. Technicians would be of considerable assistance to the consulting engineer in the drawing office and in the supervision of sites and some would go on to become qualified professional engineers. Some indication of the potential success of such a scheme is given by Mr. Holloway's statement that if this particular recognition of technican status were reached they believed the industry could absorb 600 applicants in the first year.

A really serious shortage of skilled draughtsmen and middle grade technicians was pointed out by Mr. H. D. Manning, a partner in J. D. and D. M. Watson, who also represented the Association of Consulting Engineers. The shortage of middle grade technicians seemed to be very much greater than of qualified chartered engineers. There appeared to be no great difficulty in getting senior engineers and there was a fairly large supply of graduates wanting to "come through to get training."

From Imperial Chemical Industries, Mr. J. R. Willetts, a divisional technical training officer, said that of every hundred applicants he interviewed, perhaps only three or four said that they wanted to be engineers. The figures were:

From 100 applicants, 60 wished to be chemists; 30 metallurgists; the rest physicists, with 3 or 4 engineers. The only people who say that they want to be engineers, said Mr. Willetts, were those whose fathers were professional engineers and so knew what the engineer's job was. The feeling still existed in the schools that the engineer was a man in a dirty cap going round with a grease gun.

THE ENGINEER MANAGER

Opening his paper, "The Engineer in Management," Mr. A. R. Cooper, the Central Electricity Generating Board's member for operations and personnel, showed conclusively, from their own separate points of view, why the engineer, the accountant and the secretary should be chosen for managerial preferment.

Endeavouring to outline what a manager does, Mr. Cooper identified this as having to decide what has to be done and then persuading somebody to do it. Deciding what needs to be done in the majority of cases calls for compromise and the best manager is usually the man who makes the best compromises.

Mr. Cooper is not of the computer worshipping fraternity. Cheerfully he drew laughter from the conference with the declaration that some day there will have to be a showdown—"somebody will have to tell the computer who is boss." He does not agree that we shall be able to feed everything from estimates to staff selection and trade union negotiations into the electronic machines and rely on the answers. The manager still needs to possess "horse sense," the certain something which prevents him from doing something absolutely silly—even when it has been worked out on paper.

After deciding what to do—persuading somebody to do it. Here, in Mr. Cooper's thesis, the manager comes up against a completely different set of values. The potential manager has to learn to accept without bitterness or frustration the irrationality of the human animal, especially when organised into groups. It is no use wishing men were different or trying too hard to change them.

Without being an unpaid welfare officer, or needing to be kinder or nobler than the rest of the human race, the manager should be interested in what makes men tick, in what makes people compatible or not in a working group, in what incentives and challenges stimulate different people. The man is either naturally interested in this sort of thing or he is not. There is little point in his going on a management course and finding that he ought to be.

Mr. Cooper, a member of a board of six, of whom four are engineers, delivered this sobering judgment: "engineering training and experience are valuable assets for a man who hopes to become a skilled manager, but in themselves they are not enough."

The engineer deals with inorganic material. The manager is more directly concerned with the manipulation of human material. Engineering is a precision tool with a sharp cutting edge, management is much more of a blunt instrument. It is far less definite an exercise, in which the best must very often be sacrificed to the good.

Considering those engineers who wish to become managers for the extra money, Mr. Cooper admitted that on the subject of money the figure £24,000 leapt to the mind. There was almost literally no ceiling to the rewards paid to managers. No one thought of paying astronomic sums to engineers because they were employed by others to do things. It was the man who was telling others to do things for him that got the money.

STUPIDITY AT THE TOP

Lord Wavell had said that stupidity in generals should never excite surprise for generals were chosen from that small preselected class of men who were tough enough to be generals at all and refinements of intellect and sensibility should not be expected from such heavy duty animals.

Was it possible that society at large regarded engineers as heavy duty animals, biologically unsuited for the subtler intellectual exercises of the business of managing. If that was so it was up to engineers to create a different picture of themselves to the world at large. To show that in their works they have a wider range of contacts with the individual and the community at large than any other type of professional man.

"If engineers behave like artificers they will be treated as artificers. If they want to be regarded as something potentially higher in the business hierarchy they will have to widen their spread of interests and make it obvious to the world that it is part of their creed for this widening to be encouraged."

That a widening of engineers' interests and responsibilities is normal in the course of their careers was illustrated by Sir Hugh Beaver. He recalled an experiment in which he traced what quite a large number of engineering graduates were doing when they reached the age of 40. Half of them were not doing strictly engineering jobs. They were managing, with the benefit of their engineering background.

From the floor it was swiftly pointed out that while there may once have been a time when it had to be argued that an engineer could be a manager, there were now so many proved examples that the point no longer needed emphasising. To do so was showing either a guilty conscience or a quite unjustified inferiority complex.

H. D. Manning described as nonsense any suggestion that engineering students could be taught management. The basic difficulty he thought was that engineers and scientists were today taught no English, no geography, no history and that the so-called Arts graduates were taught no science, with the result that they were quite incapable of exchanging views.

Lord Chandos so far broadened the views put before the conference that at times it hardly seemed this was still the same gathering, which, before lunch, had tended to get back to recruitment, and the inseparable trio—recognition, becoming managers and getting more pay.

DISTANT FUSION PROSPECT

An outstanding figure in his own age, Lord Chandos has a lively interest in the Italian Renaissance, a period peopled with creative men whose fame still lasts. Lord Chandos suggested that if Michelangelo, sculptor, painter and engineer, were alive today he might, perhaps, be a switchgear designer with AEI.

In the 20th century the engineer is the aristocrat. The emphasis was now on the material field and here the engineer had the training and knowledge to engage about speculations on the future of mankind, and also the means to bring those speculations to life. Looking a shade ruefully at the development costs of the early nuclear power stations, Lord Chandos took heart by looking at the prospects, now considerably lengthened, of nuclear fusion. It might be the end of the century before this source of power was harnessed but the consequence would be such that they were almost beyond the imagination today of even young men.

However exciting the prospects in the material field the obligations of an aristocracy, in this case an engineer-aristocracy, could not be confined to this alone. First and most urgent of the other considerations was the increasing size of populations all over the world. India's people were increasing by eight million a year. On a smaller scale the population of Kenya would be doubled in another twenty years. The material prosperity of mankind depended to a certain extent on the correlation between the wealth it could produce and the number of people born to enjoy it.

Engineers must devote a lot of thought to this, one of the most urgent problems of mankind—the most urgent problem, that is, if mankind is not going to use the means of modern science to destroy itself and solve over-population problems once and for all.

Lord Chandos devoted part of his time to "Engineers' English." He said: "I implore the engineering profession to devote a definite part of their time to the study of the English language, so that it may be possible for them to convey their thoughts to their fellow men. Only too often the learned professions—among them the engineers—use a vocabulary and syntax which enables them to withdraw, like the ancient alchemists, under a cloud of sulphurous smoke and hide their discoveries from the inquisitions of the outside world."

If engineers were going to be an aristocracy it would also be necessary not to rely upon translation to be in touch with the teeming thought of the rest of the world. Of every 3,000 people learning a foreign language in Britain today, only seven were learning Russian.

MATERIAL PROGRESS ONLY

On a sombre note Lord Chandos observed that with all "our marvellous inventiveness, all the progress of machines, all the research and scholarship into our tangled and troubled history, in man's relation to man we can point to very little progress, possibly even to retrogression". Was this because our best brains were not giving enough of their time to the affairs of mankind?

We had witnessed the breakdown of the League of Nations, the impotence of the United Nations, the internal struggles of Africa and Asia. The world was divided on both sides of the iron curtain and our sons and their sons were saying that they have been born into a world where their existence is far more precarious than has ever been known since the dawn of mankind.

"These are the subjects which must give you pause. It is your duty to give perhaps more than half your time and leisure to the study of the mistakes which man has made and how he has failed to carry out the Christian precept 'Love Your Neighbour.'

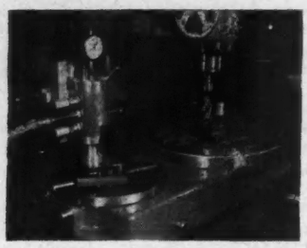
"Man cannot live by bread alone, and if you think that by the production of cheap bread you will have done all that an aristocracy should you will be sadly mistaken; you will wake up to find the people breaking your laboratory windows, and marching to Aldermaston to demand that our only means of defence should be abolished. It would indeed be ironical if all your efforts led only to the grave and that we should end by creating the means of our destruction and being ourselves the authors of our own decease.

"I wish I really had faith in the progress of man, unfortunately I do not have it. But I find it difficult to believe, in 1961, that when mankind, who has become so ingenious, and who has to his credit so many startling discoveries should, at the end, be found so obstinately stupid.

"Today we stand convicted of only progressing quickly into things which do not matter and of standing still, and even retrogressing, in things which do."

HYDRAULIC COPIER

For Profile Milling



THE HYDRO-COPIER is an attachment for fitting to a standard vertical milling or slotting machine for repetition work from a template.

Basically the unit consists of a cast base with a top casting sliding on frictionless bearings and carrying two rotating tables. These are driven through worm gearing to rotate in synchronism. A hydraulic cylinder is arranged to move the top portion carrying the tables longitudinally relative to the base, the cylinder being controlled by a valve fitted to an over-arm attached to the base casting. At the bottom of the valve is a stylus designed so that any sideways movement operates the valve spool. The whole unit is controlled from its own power pack.

Overall copying accuracy to within 0·0005 in of the template can be obtained. A centre location and a groove in both tables simplifies setting up. Cutting speeds from 2 in per minute up to 10 in per minute are controlled by the operator and compensation is automatically made for variations in cutting radius. Both internal and external profiles can be milled.

The worktable is 13 in in diameter and the template table is 10 in. The centre distance between them is 15½ in. The overall height of the table unit is 8¾ in. The maximum longitudinal traverse of the tables is 6 in and the maximum adjustments of the stylus valve are 3 in longitudinal and 4 in vertical. Maximum external and internal profiles normally possible are 15 in and 9 in respectively. An additional accessory is available for milling cylindrical cams. *Vero Precision Engineering Limited, South Mill Road, Regents Park, Southampton.*

MAGNIFIER

Room to Use Scales

A FEATURE of a new illuminated magnifier is that there is provision for using scales under it.

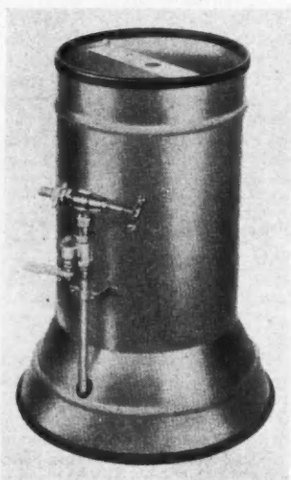
The instrument gives a linear magnification of 2× over a 5 in diameter circle. It has a body 8 in diameter and stands 6 in high. It is constructed of aluminium with rubber mouldings covering the open edges and is finished in silver grey hammer stove enamel.

The whole field of view is illuminated by a low voltage lamp that gives a white light. The lamp is rated for 24 watts at 24 volts and is supplied from a combined transformer-plug unit that operates from 110 or 250 volt mains. The transformer is encased in hard rubber and the combination of plug and transformer is little larger than a standard plug. A 10 ft lead is supplied for connecting up to the lamp and fuses are incorporated in both primary and secondary circuits of the transformer. The screen and core are both earthed.

The stand of the magnifier is cut away at the sides to allow the introduction of rulers and scales into the field of view, and the openings are large enough for the hands to move freely, and to use a pencil. The instrument can be used equally well on flat or sloping surfaces. Non-standard models for other voltages are also available. *P. W. Allen and Company, 253 Liverpool Road, London, N1.*

END-QUENCH UNIT

Tests Hardenability



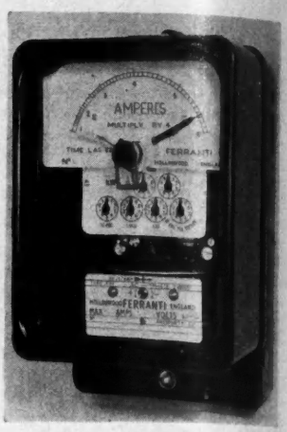
INTERCHANGEABLE holders allow specimens from 1 in to ¼ in to be accommodated in a new end-quench unit now available.

In addition to the assessment of hardenability of steels the technique can be used for non-ferrous alloys and for those where a single phase precipitates. The quench sensitivity of precipitation hardening alloys is another assessment that can be made. For the sizes quoted the standard ½ in jet is satisfactory but provision is included for changing to a smaller jet if required. Specimens longer than 4 in can be handled with a special attachment.

The unit stands 23 in high and the base diameter is 17½ in. The tank is made from 20 gauge lead-coated steel with the water jet at the closed top of a tube rising from the base, so that the wall is unbroken. The specimen carriers are located by dowel pins and are secured by milled heads. The holes in carriers are arranged to give $\frac{1}{32}$ in clearance and are countersunk on the underside to give minimum contact with the specimen. The quenched end is held ¼ in above the jet orifice. *Metallurgical Services, Reliant Works, Betchworth, Surrey.*

AMPERE DEMAND METER

Thermal Type



NOW AVAILABLE is a thermal ampere demand meter, type FMmMDA, which is a combination of a thermal ampere demand indicator and a kWh meter.

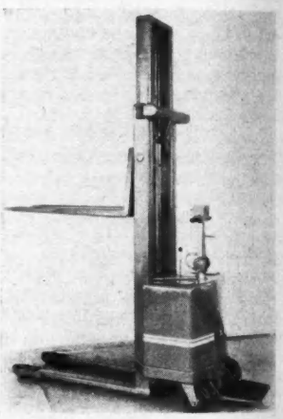
The unit has current ratings of 5 to 60A nominal, with 50 per cent overload capacity. Consumption of the thermal element is 7 W and the total consumption 10 W, at full scale current. The case is 9⅛ in by 5⅜ in by 5¼ in and the weight is approximately 6 lb.

Features of the instrument are the reduction in weight due to the use of alloy gears; viscous damping on the demand pointer; long scale length (5 in); ease of calibration; and consumption.

The indicator comprises two bimetallic strips one of which is in a chamber heated by elements through which the mains current passes. Series or parallel connection can be made according to the current rating. One end of the heated strip is anchored to a block and the other is connected by a link to the strip at ambient temperature. The other end of this strip is pivoted and carries a toothed sector which engages a wheel mounted on the spindle driving the pointer. This pushes the maximum pointer to the highest current. Time lag is 16 minutes for 90 per cent indication. *Ferranti Limited, Hollinwood, Lancashire.*

STACKER

Battery Powered



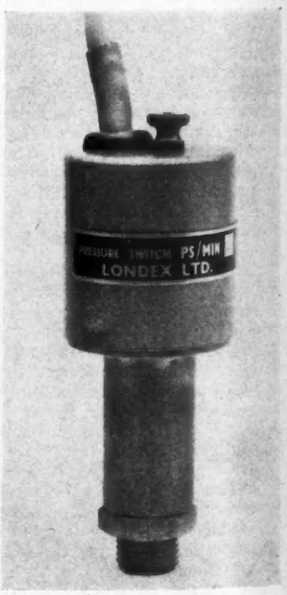
THE BT battery powered stacker is capable of lifting 2,200 lb at 24 in load centres to a height of 132 in.

Power is supplied by two 6 volt traction batteries with a capacity of 350Ah, which drive the travel motor to give speeds of 2½ mph laden and 3 mph unladen. A separate motor coupled to a gear pump operates the hydraulic lifting mechanism. Models have lifts from 92 to 132 in. The mast channels are one-piece pressings to give high strength with low weight.

The driving controls at the head of the steering handle provide two forward and two reverse speeds. The lift is operated by a push button. The steering handle can be turned 100° in both directions allowing stacking to be carried out in aisles only 79 in wide using 48 in pallets. A shoe brake is operated by raising or lowering the handle. The drive wheel is fitted with a 1 in thick solid synthetic rubber tyre and the swivel wheels are nylon reinforced Bakelite. There is a spring loaded platform on which the operator can ride for long hauls. With standard 45 in forks, the overall length of the truck is 75 in when the platform is raised. The width is 31½ in. The overall height of the model with 124 in lift is 83 in. *Rolatruc Limited, 207 Hanworth Road, Hounslow, Middlesex.*

PRESSURE SWITCH

Restricted Positions



PRIMARILY intended for use in restricted positions is the miniature pressure switch shown in the illustration.

The complete unit is 3 in long and has a maximum barrel diameter of 1½ in. It weighs 5 oz. It is supplied prewired with 4 ft of 3-core cable as standard. There are three versions with maximum working pressures of 200, 300, and 350 lb per sq. in respectively, the corresponding ranges of adjustment being 10 to 30 lb, 15 to 80, and 55 to 180 lb per sq. in. All will operate with non-corrosive gases or liquids up to a maximum temperature of 100° C.

A seamless phosphor bronze bellows is the operating element and is contained in a nickel-plated brass body. The snap action contacts are silver plated and are rated for 5A resistive at 250 ac or 2A inductive, or 2A resistive and 1·5A inductive at 30V dc. Normally single pole changeover contacts are fitted but a double pole version is also available. *Londex Limited, Anerley Works, Anerley Road, London, SE20.*

MEASURING UNIT

For Frequency or Time

MEASURING equipment type TSA3336 has provision for measuring frequency, period, simple counting and time intervals.

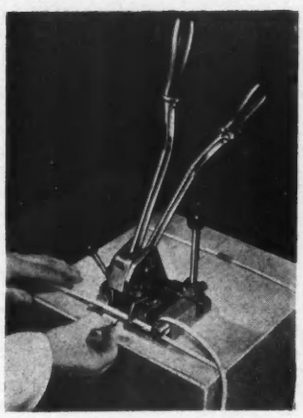
It is fully transistorised with projection type in-line readout. It can also have facilities for printout. There are six digits in the display with automatic insertion of the decimal point, and a seventh indicator shows the units in use.

Frequencies can be sampled over one of three periods: 10 second, 1 sec or 0·1 sec, the range of measurement being from 15 c/s to 1·1 Mc/s to an accuracy of ± 1 count. Period measurement (inverse frequency) is from 1 c/s to 1·1 Mc/s to an accuracy of 0·0001 per cent. Counting is for the same range as frequency. Time intervals may be measured from 1 sec to 10^7 sec (approximately 115 days) to an accuracy of 0·0001 per cent. There are eight output frequencies from 1 Mpps to 0·1 pps.

The seven divider stages are driven by a 1 Mc crystal controlled oscillator and a further six divider stages are used in the counting chain. Binary elements with feed back are used throughout. The crystal is thermostatically controlled in an oven. The display time is controlled by a switched potentiometer which allows the reading to remain until the reset button is pressed; to hold for five seconds and automatically reset again; or to vary the hold time from 5 to 0·5 seconds as desired. The equipment operates from standard mains supplies of 200-250V or 100 to 125V, 40 to 60 cycles, or from 12V dc. The case measures 14¼ in by 12¼ in by 8½ in high and the weight is 26 lb. *Venner Electronics Limited, Kingston By-Pass, New Malden, Surrey.*

FLEXIBLE STRAPPING TAPE

Non-Adhesive



FLEXIBLE strapping is now being manufactured from natural and man-made fibres and banded together into ribbons of various widths from ¼ in to ¾ in.

Its main uses are packaging reinforcement, closure, baling, bundling, palletising and multi unit strapping. Depending on the type of material used and width selected, there is available a range of tensile strength up to 900 lb for the ¾ in width.

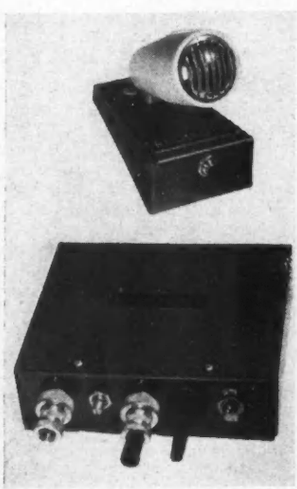
Known as "Quickstrap" and "Tufstrap," the material's flexible nature results in a particularly high shock load in relation to the total strength of the material. There is an elongation of up to 13 per cent with recovery of over 75 per cent with that elongation. This means that packages remain tightly strapped under all climatic conditions.

Both qualities are suitable for use in tropical conditions of high temperature and/or high humidity and also for below zero packaging. Tests have shown that materials are fully satisfactory over long periods at temperatures of — 30° C.

A range of hand operated tools is available for conventional strapping, perpendicular use on pressurised bales, for the strapping of irregularly shaped objects and for horizontal strapping. *P. P. Payne and Sons Limited, Haydon Road, Nottingham.*

PUBLIC ADDRESS UNIT

For Works Systems



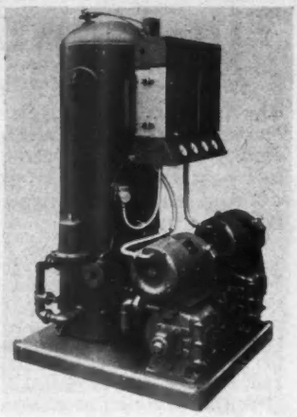
A RECENTLY introduced public address unit is designed to link into a background music system.

The equipment consists of a microphone and a preamplifier which measures 6 in by 5 in by 2 in and contains its own power supply. Located on a single panel are the input and output connections, the mains input socket, mains switch and a preset volume control. The preamplifier box is connected to a modified tape player.

Pressing the button on the microphone automatically cuts out the music and clears the line for speech. After the announcement has been made, releasing the button allows the music programme to be resumed. The company lease the address equipment as an optional extra to their background music equipment which employs a self-contained tape player measuring 11½ in by 8½ in by 11 in. This holds a 90 minute tape in a continuous loop. Cassette loading is used so tapes can be changed easily. The player is capable of driving 100 loudspeakers to a total power of 10 watts; tapes are available from a library. *Reditune Limited, Wrencote House, High Street, Croydon, Surrey.*

MARINE WATER PRESSURE SETS

Smaller Storage



NEW Auto-Unit water supply sets provide fully automatic operation and also considerably reduce the size and weight of pressure tanks necessary.

The complete equipment, including the pressure tank, is delivered and installed as a single prefabricated unit, which allows the whole of the assembly, including wiring, controls, and pipe connections, to be carried out under workshop conditions.

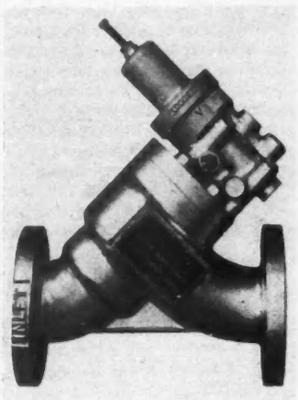
Meeting the requirements of Lloyd's Register and the Ministry of Transport for sanitary and fresh water services, the units are made in an extensive range of standard sizes with pump capacities up to 25 tons per hr. The pumps operate with a standard cut-out pressure of 80 lb per sq. in, a pressure regulator or reducing valve keeping the pressure in the system at the required level.

A simple combination of a pressure switch and a two-way float switch provide automatic control of the pressure and of the air volume in the tank. If a suitable air supply is not available, the control can be arranged to start up a small compressor.

Each set is fitted with two pumps, one of which is a standby, and either of them can be brought into use on automatic or hand control. *Megator Pumps and Compressors Limited, 43 Berkeley Square, London, W1.*

CONTROL VALVES

Pilot Operated



UNIT construction is a feature of the new range of Brodie pilot operated control valves known as the 500 series.

The basic unit is the main valve to which is added a pilot assembly designed for operation hydraulically, pneumatically or electrically. There are two main types: those for on-off control and those for regulation. In both, all the internal parts, including the seat ring, can be removed as units without disturbing connections.

The main valve is a spring loaded piston the upper side of which is connected to the upstream (closed) or downstream (open) side by the pilot valve. In the regulating types the pilot is controlled by the downstream pressure from sensing elements giving a pressure reducer controller. Another version is used as a pressure relief valve. The type for controlling rate of flow depends on maintaining a constant pressure drop across an orifice or a meter in the stream. In all cases it is the line pressure that is used to operate the main valve.

There are seven sizes in the range, for pipes from 2 in to 12 in and for pressures up to 600 lb per sq. in. Working temperatures are up to 150° F and under these conditions, all sizes have standard linear valve characteristics. Bodies are made of steel. *Gilbarco Limited, 740 High Road, Tottenham, London, N17.*

V-BELT

High Capacity Low Stretch

NOW being made available in this country is the range of V belts manufactured by Trelleborgs Gummifabriks a.b.

The high capacity belt is made in what is called the grommet finish. It has two endless power transmitting cores made up of twisted rayon cord thoroughly embedded in rubber and set at the pitch diameter of the belt. It is claimed that five grommet belts will replace seven of the standard type. Also the stretch of the high capacity belts is 65 per cent less than that of the standard belts, resulting in less frequent adjustment and more even drive.

In standard belts there is always a certain amount of heat generated by the friction between the parallel layers of cord; with the grommet belt this is said to be eliminated resulting in longer life, perhaps up to 50 per cent. The high capacity belts are available in three standard profiles; all will withstand oil. *Bolinders Company Limited, 4 Lloyds Avenue, London, EC3.*

Tin-Aluminium Bearings for Big Ends

Reticular 20 per cent tin-aluminium bearings offer high fatigue strength with good surface qualities. So they are very suitable for highly-stressed big-end bearings. They also resist corrosion.

IN MEETING the desire for higher performance in car engines by producing a higher output per cylinder, the engine designer is creating a need for more rugged big-end bearings. Present types of bearings are reaching their design limits. On the one hand the traditional tin-base and lead-base alloys are unduly limited in the loads they can carry at current operating temperatures, and on the other, the copper-base alloys (copper-lead and lead-bronze) are prone to cause rapid crankshaft wear under adverse operating conditions, and are liable to corrosion. These two disadvantages of copper-base alloys can be overcome to some extent by the use of lead-base overlays, but such overlays can fail by wear or fatigue and may thus give only temporary protection.

The requirements of a new bearing material can be summarised as follows: it must have two to three times the load-carrying capacity of tin-base and lead-base alloys at normal operating temperatures, and must be resistant to corrosion by all lubricants in all conditions likely to be encountered. The material must at the same time resist wear, both of itself and of the journal surface, when operating with a lubricant contaminated with abrasive particles; and it must be resistant to scuffing or seizure under conditions of temporary lubrication failure. That is, it must have good bearing surface properties.

A bearing material that shows promise of meeting these requirements is reticular 20 per cent tin-aluminium. Its behaviour in laboratory and road tests is described in a paper, "The Development and Performance of Reticular 20 Per Cent Tin-Aluminium Bearings," by P. G. Forrester, M. J. Neale, and A. D. Newman of the Glacier Metal Company Limited, presented to the Institution of Mechanical Engineers and sponsored by the Lubrication Group.

In aluminium-base alloys of high tin content, tensile strength, yield strength and ductility fall off sharply if the tin matrix completely envelopes the aluminium grains. This can be avoided by working and annealing. After such treatment the tin remains continuous along grain edges but not across grain faces, so that a strong, continuous aluminium-base matrix is established. The network so formed by the tin phase gives rise to the name "reticular" tin.

To produce a bearing, the high-tin alloys are bonded to steel. This is carried out by alumising steel strip and rolling it with 20 per cent tin-aluminium strip. With the correct surface preparation and the right temperature of rolling, a satisfactory bond is formed.

Tests were carried out to establish the potential load carrying capacity of this material. The bearing to be tested was carried in an eccentric journal and used to reciprocate a piston in an oil-filled cylinder. The peak pressure of the oil was controllable and the bearing loading was proportional to it. Tests were made on bearings of 2 in bore and 1⅛ in length, at a speed of 2,500 rpm. SAE 10W oil was used at an inlet temperature of 70° C, and an inlet pressure of 70 lb per sq. in. The limit of loading on the machine was 14,000 lb per sq. in and this was found insufficient to produce a fatigue failure of the reticular tin bearing.

From the results it was estimated that the potential fatigue limit (10^7 cycles) of the new material in the form of lubricated bearing was 15,000-18,000 lb per sq. in. Comparative figures for other materials are shown in the table.

A second series of tests was then carried out using a machine that simulated engine conditions more closely. In it the cyclic loads are produced by using out-of-balance masses. The bearings are the same size as for the other machine but run at 4,000 rpm. The rating for fatigue limit of steel-backed white metal (0·015 in thick lining) in this machine is about 1,600 lb per sq. in.

Load-carrying Capacity of Various Bearing Materials

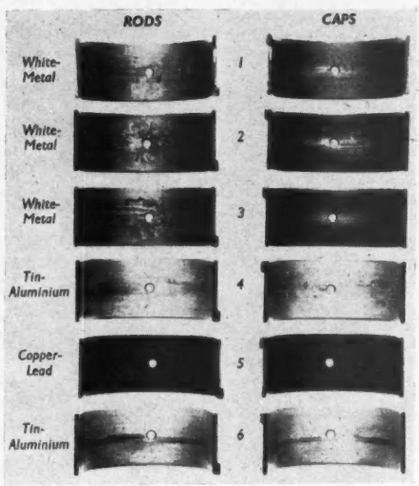
(Pulsating Load)	Lb per sq. in
White metal (tin based) 0·015 in thick on steel ..	5,000
White metal (tin based) 0·004 in thick on steel ..	7,000
Overlay plated (lead-tin, 0·0015 in thick) copper-lead on steel	8,800
70/30 copper-lead on steel	11,000
Reticular 20 per cent tin-aluminium (0·015 in thick) on steel	14,000

For rectricular tin-aluminium the figure was 4,000 lb per sq. in.

In these tests the reticular tin bearings gave satisfactory general performance; misalignment of the shaft in the second machine, for example, was accepted by the material without any trouble. No corrosion problems were met.

ROAD TESTS

Road tests were carried out by fitting the reticular tin-aluminium bearings in a number of production cars. However, when a high-performance material such as reticular tin-aluminium is used in tests of this nature, it is not being loaded to the same proportion of its capacity as are other bearing specifications in most of the engines involved in the work, since the engines were designed to use bearing materials of lower strength. The results obtained, therefore, were those of general performance and wear of both journals and bearings at what are usually relatively low loads for the reticular tin-aluminium bearings.



Measurements made showed that journal wear against 20 per cent tin-aluminium was on average 70 to 80 per cent of that against 70/30 copper-lead—the nearest equivalent bearing material in strength. The wear of the reticular tin-aluminium itself was similar to or slightly less than that of the copper-lead, so that the change in clearance was less when reticular tin-aluminium bearings were used. At the other end of the scale, comparing the reticular tin-aluminium bearings with tin-based white-metal bearings, the journal wear against the former was generally between 100 and 160 per cent of that against the latter, and in clean engines the wear of the reticular tin-aluminium itself was less than that of the white metal. In many engines it was found, however, that the white metal became packed with embedded particles, giving the appearance dimensionally of "negative wear," with the tendency to a sudden and rapid increase in the rate of wear of the corresponding journal as a consequence. The reticular tin-aluminium material did not display this tendency.

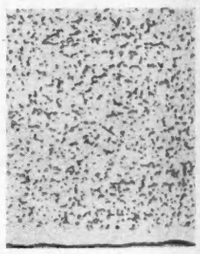
No corrosion was found under the engine conditions of these tests. Another important property that has appeared as a result of field experience, is the ability of rectricular 20 per cent tin-aluminium to operate satisfactorily against a soft steel or cast-iron shaft—a property that is not held by its nearest equivalent in terms of load-carrying capacity.

CAVITATION EROSION

Before reticular tin-aluminium was brought out, higher bearing loads in reciprocating engines were tackled by using a bearing whose surface consisted of a very thin layer of soft alloy over an under layer that had reasonable bearing properties and high fatigue strength. Generally a lead layer of about 0·00125 in was plated over an under layer of copper-lead or lead-bronze. The lead alloy overlay runs satisfactorily against a soft crankshaft, but the lead-bronze or copper-lead underlayer will not do so, as it gives a high rate of shaft wear. Since the under layer is likely to be exposed in service eventually, it is often necessary when using such bearings to harden the shaft and fit a good oil filtration system.

Reticular tin-aluminium, having higher fatigue strength than such overlay-plated bearings, will run against soft crankshafts with a lower rate of wear than copper-lead and a much lower rate than that of lead-bronze. It has the further advantage that it is not attacked by acid engine oils, and is therefore ideal for use in hot running engines, such as air-cooled diesels, where corrosion of lead alloys tends to be severe.

Another problem in modern diesel-engine bearings is cavitation erosion. This is a severe attack on the bearing surface caused by the sudden collapse of low-pressure regions in the oil film. The low-pressure regions are caused by oil surges in the crank drillings, oil surges into the main bearing grooves during sudden changes of bearing load, and by discontinuities in the oil films in the bearings themselves. This problem is more prevalent in diesels because of the more rapid rise in combustion pressure.



(Left) A selection of big-end bearing materials after 37,000 miles in a 2·4 litre high performance engine.

(Right) Typical microstructure of reticular 20 per cent tin-aluminium on steel.

Resistance of materials to cavitation erosion is primarily a function of their hardness, and since reticular tin-aluminium is harder than the soft lead-based surface layer on an overlay plated bearing, its resistance to this form of erosion is higher. In a number of instances, by changing to rectricular tin-aluminium it has been possible to retain the existing bearing dimensions and eliminate cavitation erosion damage.

Aluminium-based alloy has a high thermal conductivity. This is a consideration that becomes more important as engine speeds increase, since the high speeds will lead to high bearing surface temperatures. High speeds are often associated with load variation due to unbalance; and however slight this may be it can cause pronounced effects at high speeds. These factors seriously limit the life of white metal, whose fatigue strength falls rapidly with increasing temperature. Reticular tin-aluminium, however, with its high conductivity, high fatigue strength and relatively low rate of fall of fatigue strength with temperature, is clearly a valuable material in such circumstances.

Human Element

Inspectors Are Better Checkers

SINCE it is from time to time suggested that inspectors of work in factories should be given a change of work at intervals in order to keep them more alert, an authoritative comment that such a move may make the inspector less reliable than usual when he first gets back to his normal work is worth looking into.

The suggestion follows from the report "Absolute Judgments and Operative-Inspector Relations," by I. D. Brown of the Medical Research Council, Applied Psychology Research Unit, Cambridge, in the current issue of *Occupational Psychology*, the journal of the National Institute of Industrial Psychology.

The starting point for this laboratory experiment was the well known position that production workers often believe that inspectors are not consistent in their standards and will one day pass a piece of work of identical standards to one which on another occasion they will fault.

Disputes in the furniture industry in which checkers held that their own standards were more consistent and that the operatives' judgments varied excessively led to the laboratory experiments, which showed that in the main the inspectors were in the right.

In his summary, the Medical Research Council's author writes that discrepancies between the subjective standards of the operatives and the inspector making absolute judgments could have been due partly to a difference in the frequency with which judgments were made, and to the greater range of sensory experiences of the operatives, which altered their level of adaptation.

When these two factors were investigated under laboratory conditions it was found that "operatives" made nearly 50 per cent more errors than "inspectors" under simulated industrial conditions, because they were unable to adapt progressively to the required standard of judgment.

If the example of testing the swinging fit of a door or the sliding fit of a drawer is taken, it can be seen that the test may be of the amount of muscular effort needed to overcome the resistance of the movable part. The man who makes a large number of other movements between making the tests, as the worker making the next parts must do, is much less reliable than the man who does nothing but tests of the same type one after another.

New Pay and Status for Council Workers

One more twist to spiral of local authorities' costs, though one that is hardly likely to evoke disapproval, has been given by the agreement to grant a 4 per cent increase to the 500,000 manual workers employed by the municipal departments. These are the workers who have for long brought up the rear of the national income columns and the general increase conceded is one of 2*d* an hour. It may cost the local authorities between £10 and £11 million in a full year.

The new agreement not only raises earnings but introduces some wider differentials, increases the status of a proportion of the men, and gives extra pay for weekend working. Taking all this into account, though without the weekend pay, the wage increases will range from 6*s* 11*d* to over 20*s*.

Local authorities employ about 7,000 engineering craftsmen and these have been awarded 3½*d* an hour more, bringing their hourly rates to 5*s* 11½*d* in London, 5*s* 7½*d* in principal industrial centres, and 5*s* 6½*d* elsewhere. The request for substantial pay increases came from the unions; the proposal for the changes in grading and classification from the employers.

More for Universities and Civil Defence

Instalments on the construction of an engineering building, a library, and a chemistry building at the new University of Sussex appear in the Civil estimates published earlier this month providing an additional £12·7 million in grants to universities and colleges in Britain in the year 1961-62.

Local education authorities in England and Wales will receive £62 million of the total estimate of £82·7 million. The figure for grants and loans for educational services and research provided other than by the local authorities has increased by almost £5 million to £27 million.

From the £2·6 million contribution to science and the arts, £1·7 million is for the Arts Council, an improvement in their grant of £175,000. Civil defence costs are to go up by £2·3 million to £10 million. This is largely due to pay awards, better grants to local authorities, the replacement of equipment and improved warning and monitoring services.

Union Disapproval at Unofficial Strikes

One of the most lively of the trade unions with members in the motor industry, the National Union of Vehicle Builders, has issued a detailed warning to its membership warning them not to take part in unofficial strikes and not to accept orders from unofficial bodies.

The executive committee of the union emphasise in their statement that efforts should be made to settle disputes through the official negotiating machinery. There is an echo here of repeated appeals from the employers in a long line of industrial disputes.

The NUVB executive recommends that if negotiations fail to produce a settlement then the matter should be reported to them. They alone, under the union's rules, have the right to authorise strike action. There is no doubt what the executive mean when they point out that, if the laid down procedure of negotiation with the management followed by report to the executive is not carried out, any action which follows may not be authorised. Accordingly, benefit will not be paid.

A direct challenge to union leaders' authority has been seen in recent years as unofficial committees have gone their way in the docks, the power generating industry or simply at shop steward level generally. The NUVB executive recognise this when they say that the taking by their members of orders from bodies which have no authority under union rules is a more serious matter (than unauthorised action).

Advice, recommendations or instructions from such bodies are all proscribed and the executive statement lays it down that only executive committee instructions should be carried out. As in the previous case, if these instructions from outside are followed, benefit will be withheld.

And presumably in case any branch has the short cutting idea of simply using its income to pay benefit in actions not approved by the executive, the NUVB statement deals with that too by saying that branches will not pay dispute benefit out of normal income.

The Vehicle Builders, now taking this tough line with unofficial activities, last year declined to take part in the Trade Union Congress inquiry into strikes and the activities of shop stewards.

The Seeing Eye Surveyed

The closed circuit television exercise at Barnhill Secondary Modern and Hayes Grammar schools, both in Middlesex, was as remarkable for the care taken to provide the means to watch the reaction of the watchers as for the television experiment itself.

The "live" science lesson was going on in the Hayes school. Microwave equipment had been fitted up in order to transmit pictures from the schoolroom to the secondary modern school two miles away. It is the first time such a step has been taken in the regular curriculum of a British school; it is also essentially school-to-school television and not at all the same thing as the multi-schools television services offered by the BBC and ITV.

Registered with the National Foundation for Educational Research the experiment is to last for a full term.

The first of the cameras provided in the classroom, by Pye, whose company—High Definition Television—is responsible for the scheme, covers the teacher and his blackboard. The second of the two small industrial cameras is for enlarging small objects and for close-ups in scientific experiments. A third camera is contained in a console with 16 mm film projector and provides telecine facilities.

Headmaster's Screen

On his desk the teacher has a switcher unit with which he selects cameras and sound circuits. Round his neck he wears a microphone.

Barnhill School, the receiving end, has a high-definition schools 27 in receiver and the teacher has his own monitor screen. A monitor screen is also provided in the headmaster's study which conjures up a vision of tennis neck as an occupational disease among the headmasters when several systems are working simultaneously in the same school.

Arrangements are also made for teacher and pupils to make comments and ask questions. Each classroom has specially equipped microphones with 2 ft parabolic dishes capable of being aimed at individual pupils in the class and so picking up their remarks.

Assessment of the Hayes-Barnhill experiment has been helped by the installation in the Barnhill classroom of a further camera, placed so that it can record the reactions of the pupils without itself being obtrusive. Pictures from this camera are relayed only to the room in which the experiment is being demonstrated. In that room two large screens make it possible to watch both the original lesson and the reaction of the receiving pupils.

Better Business Study Courses

An impressive list of professional bodies have agreed to give subject-for-subject exemption from their intermediate examinations to holders of the new Ordinary National Certificate Diplomas in business studies whose details have been announced by the Ministry of Education.

From the autumn, commercial and technical colleges will be offering new courses in business studies leading up to the ordinary and higher certificates, which are designed to take the place of the former National Certificates in Commerce.

The Ministry of Education is hoping that the improvements in the courses will prove a stimulus to further development in business studies. Among the introductions is a full time two year course leading up to the Ordinary National Diploma in Business Studies.

The professional organisations prepared to make the intermediate examination exemptions, provided the student has passed with not less than 50 per cent marks, are:

The Chartered Institute of Secretaries, the Advertising Joint Examination Board, the Association of Certified and Corporate Accountants, the Building Societies Institute, the Chartered Insurance Institute, the Corporation of Secretaries, the Institute of Bankers, the Institute of Cost and Works Accountants, the Institute of Export and the Institute of Transport.

New Chiefs for BEAMA

Anthony M. Browne, chairman and managing director of Hackbridge and Hewittic Electric, has been elected President of BEAMA, the British Electrical and Allied Manufacturers Association. A member of the Association's Council for seven years, Mr. Browne is a member of the BEAMA export panel. He also sits on the recently formed Export Council for Europe.

At the same Council meeting Mr. H. H. Mullens, chairman and managing director of A. Reyrolle and chairman of C. A. Parsons, was elected deputy President.

Carmen Give Shield to Hovercraft Inventor

The inventor of the Hovercraft, Mr. Christopher S. Cockerell, has been awarded the Viva shield of the Worshipful Company of Carmen.

Awarded each year, the Viva shield is given by the livery company for the most outstanding achievement in the field of transport. Mr. Cockerell will receive the shield, gold medal and citation at a ceremony in July.

Fig. 1 The completed side tower on the south bank. To the left are the main towers under construction, and to the right the railway bridge.

The Forth Road Bridge Superstructure

Construction of the superstructure of the Forth Road Bridge is up to schedule. Many innovations in suspension bridge design have been introduced and are described in the following pages. Great attention has been paid to safety during construction.

WORK on the towers for the Forth Road Bridge will be complete in little more than a month. Then will begin the preparations at site for spinning the cables, the first time this work has been attempted on such a magnitude outside the United States of America. The whole project will be completed in 1963.

The bridge, with its centre span of 3,300 ft, will be the fourth longest suspension bridge in the world, though completion of the longest of all—between Staten Island and Long Island, New York, with a clear span of 4,260 ft—will follow shortly afterwards. In design and erection techniques many innovations have been adopted for the Forth Bridge. Grip bolts are being used for making most of the site connections; in the towers especially, large sections—weighing up to 35 tons—are being prefabricated to minimise site work; the steelwork is being grit blasted and zinc sprayed before painting, and it is expected that it will be 20 years before any considerable surface treatment is required; for the first time too, prestressing has been adopted in the cable anchorages, so that movements at the face of the anchorages as load is put into the cables will be small. The permitted loading is exceptionally high, the design having taken into account the passage of 180 ton vehicles.

The safety of the steel erectors has been treated as a matter of paramount importance. For the construction of the towers, the "climbing structures" (described later) carry bolting up cages that reach to all parts of the work, giving the men maximum protection against a fall. When the deck structure is being built, safety nets will be slung beneath the working area. Any man working on the bridge may have a parachute type harness that will ensure his safety even if he takes a long fall.

The consulting engineers for the design and supervision of the construction of the bridge and its approaches have been Mott, Hay and Anderson of London, in association with Freeman, Fox and Partners, also of London. It is being built for the Forth Road Bridge Joint Board, which was established by Parliament to procure the construction of the bridge and to control its operation as a toll bridge. The capacity of the bridge is intended to be sufficient until at least 1975-80, but the way in which new routes can generate traffic as well as attract the existing flow suggests that it will be used to the full before then.

The site of the new bridge is very close to that of the great railway bridge—a matter for appreciation by the bridge engineer, who will be viewing simultaneously two magnificent examples of his art, as well as by the tourist. The story of the bridge is a long one which, in even its modern form, goes back to 1923, and Mott, Hay and Anderson were first appointed to make surveys for a suitable site in 1926. They finally recommended the Mackintosh Rock site—where the bridge is now being built—in 1931 and their scheme called for a bridge with a 50 ft roadway estimated to cost £4,250,000. Disagreement over sharing the cost caused much delay, and the Second World War put the whole thing into abeyance, but in 1947 the present Joint Board was established and Mott, Hay and Anderson were appointed consulting engineers, with Sir Giles Gilbert Scott as consulting architect.

Alternative projects, including a tunnel, a tube on the bed of the Firth and Sir Bruce

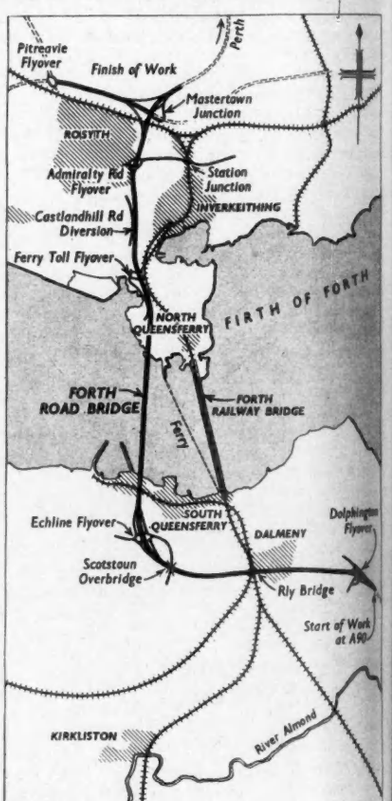


Fig. 2 The new road system being built as part of the bridge project.

White's plan for a road deck through the railway bridge, were examined and rejected in turn. In 1956 the bridge project was confirmed as being the most suitable and in the November of that year the Government agreed to contribute £4,650,000 and the local authorities £500,000, the rest to be found by loans repayable out of toll revenue. The bridge will replace what has become a grossly insufficient ferry service or, alternatively, save a 50 mile detour to the next crossing over the river. In its final form the project involves not only the bridge but a modernised road system on both sides of the estuary, as is indicated in Fig. 2.

The first contracts were let in August, 1958, and the distribution of work between the several principal contractors is shown in the table. As will be seen the largest contract, that for the bridge superstructure, is larger than all the others put together. At the moment the project is up to schedule. John Howards have completed their work at site. The road works are under way. Preliminary work for the viaducts at both ends of the bridge has been started. As already stated, the steel towers are nearing completion and spinning the cables—the next important phase—will begin in September and should be complete by the end of the year.

The contractors for the superstructure are the ACD Bridge Company Limited, a partnership of Sir William Arrol and Company Limited, who built the original Forth bridge, the Cleveland Bridge and Engineering Company Limited and Dorman Long (Bridge and Engineering) Limited. Their site manager is Mr. H. Shirley Smith, M.I.C.E.

Arrol incidently, are not the only firm with a direct connection with both the old railway bridge and the suspension bridge. The six million rivets used on the older bridge were obtained from the Clyde Rivet Company; this company was amalgamated with others to form the rivet, nut and bolt group to which A. P. Newall and Company Limited of Glasgow belong and Newall are the suppliers of the grip bolts used almost exclusively for making site connections on the new bridge.

It is expected that the maximum labour force working on the superstructure will be between 250 and 300 men during the time that cable spinning is in hand as compared to the 6,000 who were employed on the Forth railway bridge.

Principal Contracts

	Description of Work	*Contractor*	*Contract Let*	*Value*
1	Foundations and piers for main towers, the two RC side towers, and the cable anchorages	John Howard & Co. Ltd., London	August, 1958	£2,200,000
2	Supply and erection of steel superstructure, including the towers, spinning the cables, and constructing the deck	ACD Bridge Co. Ltd., London	August, 1958	£8,660,000
3	Southern approach roads of 3 miles, including flyovers	A. M. Carmichael Co. Ltd., Edinburgh	June, 1960	£800,000
4	Viaducts at both north and south end of bridges	Reed & Mallik, Ltd. Coupern Lane, Romsey, Salisbury	December, 1960	£918,000
5	Northern approach roads of 6 miles, including flyovers	Whatlings & Co. Ltd., Glasgow, C3	December, 1960	£2,220,000

20 Years Protection for the Steelwork

Three grades of surface protection for the steelwork are being applied between fabrication and erection. It is believed that no major renovation of the bridge superstructure will be required for 20 years.

The decision to employ large prefabricated welded units, with extensive site bolting, went hand in hand with the decision to adopt metal spray protection for the steelwork. It is believed that the treatment will have a life of 20 years. To this end, a plant has been established by the ACD Bridge Company on a disused airfield at Drem, about 30 miles from the site on the south side of the Forth estuary. The plant was designed to handle major pieces of prefabricated steelwork, such as the tower boxes and the deck panels; to date all the steelwork has been taken to Drum and then, after processing, dispatched to the site by road. The almost unlimited standing room at the airfield has proved invaluable as a store from where dispatch to the more confined site could be controlled to suit the erection programme.

Fig. 3 Most of the high grade zinc coating has been applied by machine, but smaller pieces are are being processed by hand.

Three grades of protection are being processed at Drem:

A: For all external surfaces, the steel is shot blasted and then zinc sprayed, followed by four coats of paint as detailed below. The specification calls for metal coat thickness of 0·003 in, but in practice the thickness is working out at 0·0035 in. (Areas which will form mating surfaces between members are not painted so that there will be no interference with the clamping action of the grip bolts; after erection, areas around connections are touched up by hand, as are any patches that have been damaged during handling and transport.)

B: External surfaces of the sections which will be internal surfaces of the completed structure—the lift wells in the towers are an example—are shot blasted and then given two coats of red lead paint.

C: Internal surfaces are being wire brushed and then given two coats of red lead.

The principal sections to be handled at Drem are the tower boxes, the largest of which are 12 ft by 5 ft by 47 ft 6 in long, and the deck panels, 8 ft wide by 60 ft long. From the beginning, it was realised that no standard grit blasting equipment was suitable for the job and that the plant would have to be designed from the first principles and this side of the work was put out to Spencer and Halstead Limited, of Ossett, Yorkshire, who designed and installed the equipment used.

Both compressed air blasting and the " airless " method were considered and though the former, using hand-held guns, offered greater flexibility, the number of men required and the horsepower required to do the volume of work in the available time made it a most expensive proposition.

It was therefore decided to instal equipment using two impellers mounted on a rise-and-fall carriage which enables a 5 ft width to be cleaned on one side only as the sections are traversed; the movement is then reversed, the impellers raised, and another 5 ft band treated along the length of the member. The member is then turned over and the other sides grit blasted. Pockets or surfaces shielded from the blast stream are dealt with by a small number of manually operated guns.

The percentage of surface cleaned depends on the section, but on an average it proved most economic to work a full day shift (56 hours a week) on machine blasting and to combine this with a night shift (46 hours) using hand equipment. Small sections that are not suitable for handling by the plant are to be contracted out.

All shot blasting operations are carried out within an area enclosed by rubber curtains. The curtains on the impeller side are of roller construction to allow them to take up the space between the roof of the blast enclosure and the impeller carriage whatever its height. The side curtains are of the " concertina " type. Complete shot return and cleaning systems are incorporated and both the powered and the manual cleaning chambers are ventilated by an exhaust and dust collecting system. Arrangement of the plant is such that it can be moved to a new site for similar work elsewhere.

Similar difficulties concerning the availability of plant were found with the metal spraying equipment as with grit blasting equipment. A purpose-made machine, of the same capacity as the blasting machine, was designed by Metallisation of Dudley, Worcester, and installed in the same hangar at Drem. The standard of spraying is extremely high, more in keeping with factory standards than those previously associated with structural steelwork, with very little sign of splatter or unevenness. Some hand work on small pieces is necessary, as shown in Fig. 3.

As already pointed out, internal surfaces are not sprayed but are given two coats of red lead,

Fig. 4 Wherever possible, rollers are used for painting.

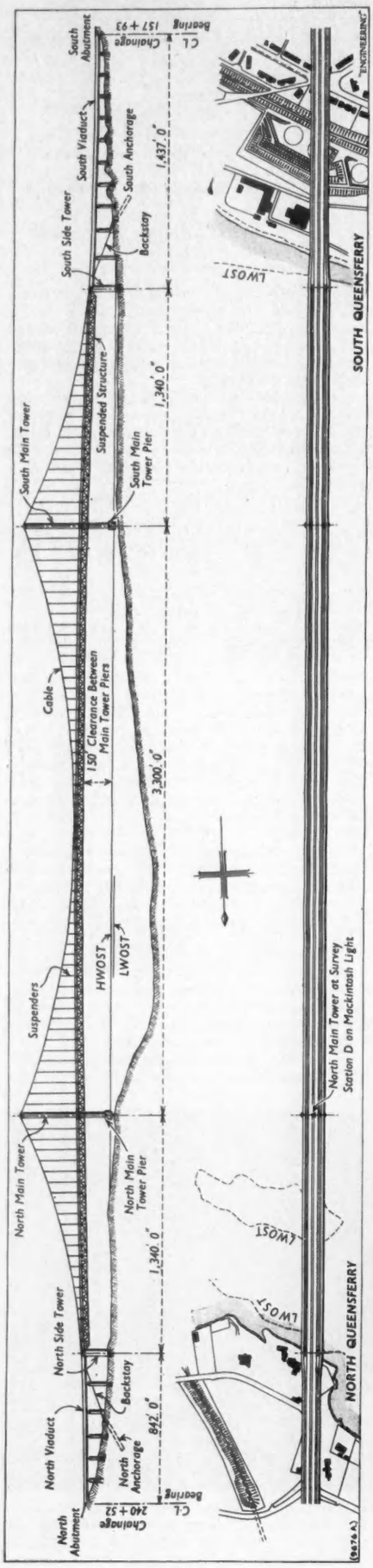


Fig. 5 Elevation and principal dimensions of the Forth road bridge.

the undercoat containing pigment (black) to make it distinguishable from the second coat.

From all external surfaces, a four coat paint protection system has been adopted, using materials supplied by Griffiths Brothers and Company Limited, London, of Armour Works, Wednesfield, Staffordshire. After much experimental and other investigation the paint "system" finally adopted was as given below.

Coat	Paint	Drying time
First, etch primer	Armourseal E	1 to 2 hours
Second, primer	Armourseal 608—Phenolic zinc chromate	4 to 6 hours
Third, undercoat	Ferrodor—Phenolic micaceous iron oxide (steel grey)	6 to 8 hours
Fourth, top coat	Ferrodor—Phenolic micaceous iron oxide (silver grey)	6 to 8 hours

The investigations were carried out by the engineers in collaboration with Dr. T. P. Hoar of Cambridge University. Tests of all paint as manufactured are being made by the Chatfield Applied Research Laboratories, Croydon.

At Drem, care is taken to limit the time delay between successive coats as follows:

Zinc spray to first coat	Soon as possible, but not more than 72 hours
First to second	3 to 24 hours
Second to third	6 to 24 hours
Third to fourth	Any time

All the paint is being applied by rollers, Fig. 4, except where brushes are required to get into corners. It has been found that painting is done more quickly and that more uniform coats are applied.

To date about 60 per cent of the steel in the towers has been processed, including the bracing and some of the walkway brackets. Some of the deck panels have arrived but as yet none of them has been treated; no truss steel for the decks has yet been received, erection not being due to begin before the end of the year.

Main Tower Fabrication

A very high degree of accuracy was demanded in the fabrication of the main towers.

THE main towers are about 500 ft high above their concrete bases and consist of twin legs of cellular steel box construction braced horizontally and diagonally. The maximum working vertical load to be carried by each tower is 20,400 tons and the side loading on a free standing tower in a 110 mph gale is 464 tons. No serious consideration was given to the use of reinforced or prestressed concrete for the towers. Permanent lifts are to be installed in one leg of each main tower.

The make up of the towers is shown in the sections and elevations in Fig. 7 and the finished north tower is to be seen in Fig. 14. The towers are made of high tensile steel, prefabricated into "boxes" which, with cover plates, are site bolted to form cellular structures. This design, exploiting the advantages of shop manufacture and site bolting, thereby minimising the site work and also reducing the specific steel content of the tower, is claimed to be a significant advance in suspension bridge design. Basic also to the design is the climbing ring structure used in the erection of the towers.

The two legs of a tower are at constant 78 ft centres and each is made up of eleven lifts of between 35 ft and 47 ft 6 in, each lift comprising five cells consisting of three prefabricated boxes joined by cover plates (Fig. 7). The towers have a constant width of 9 ft but, in the length of the bridge, taper from 24 ft at the base to 18 ft, the taper being obtained by varying the side dimension of the outer boxes. The larger centre box protrudes towards the middle of the tower and is the means of fixing the cross bracing. There are 3,000 tons of steel in each tower.

After the bases had been correctly placed on the piers, true erection of the towers depended solely on the accuracy of prefabrication of the boxes and of the correct mating of machined faces at the top and bottom of the boxes. For the completed north tower, the resultant error in position at the top of the tower is negligible—less than $\frac{1}{4}$ in in either direction.

The high tensile steel plate in the boxes is mainly between $\frac{1}{2}$ in and $1\frac{1}{8}$ in thick, though in certain places $1\frac{1}{2}$ in plate has been used. Each box is stiffened by longitudinal and lateral diaphragms. Mild steel has been used for the two sets of cross bracings immediately above the road level, but the topmost bracings and those below road level are of high tensile steel. Like the main tower members, the bracing is also of prefabricated welded box construction, site bolted into position; the box members are 5 ft by 3 ft in section, with the wider faces stiffened

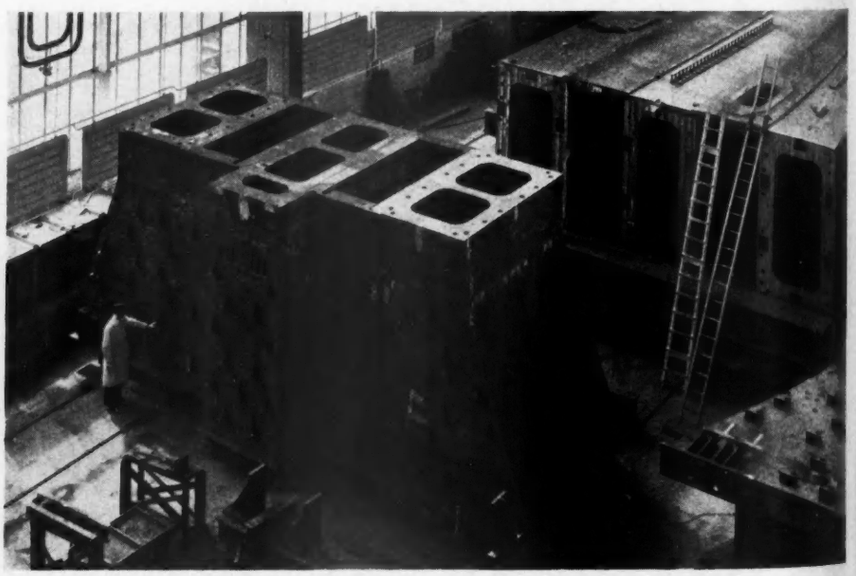


Fig. 6 The foot of a main tower leg, showing the five cell formation and the machined faces between lifts on which the accuracy of tower erection depended

internally by welded angle pieces. In detailing the design, allowances have been made for a compression under load of 1 in in the tower below road level and of 3·35 in in the full height.

A brief word requires to be said about the horizontal bracing of the tower at road level. It is a large box girder, nearly 6 ft deep by 5 ft wide, with flying outriggers along the line of the bridge. It carries the make-up section of the roadway between the main span and side span decking and the expansion joints. Some details of the support given to the ends of these spans and the arrangements to accommodate expansion are described in the section dealing with the design of the deck.

Fabrication of the steelwork in the towers has been done at the works of Sir William Arrol in Glasgow, the steel being plate and sections being obtained from nearby Colvilles. From Arrol's the sections were sent by road to Drem for grit blasting, zinc spraying and painting.

The importance of accuracy of workmanship in the steelwork for the towers has already been referred to. No tolerances were given on the drawings, the pieces being made as near dead true as was possible. Before assembly, the plates were trimmed and otherwise machined in batches to ensure that meeting faces would match accurately. The welding procedure was devised to minimise distortion. After assembly of the boxes, considerable lengths of the towers were pre-assembled on the shop floor and the alignment checked; the ends were then machined, and where necessary, re-machined to obtain a satisfactory job. This process was repeated continuously from the base to the top of the towers so that the fit of every member was checked and counter checked before dispatch. The heaviest prefabricated member weighed 35 tons.

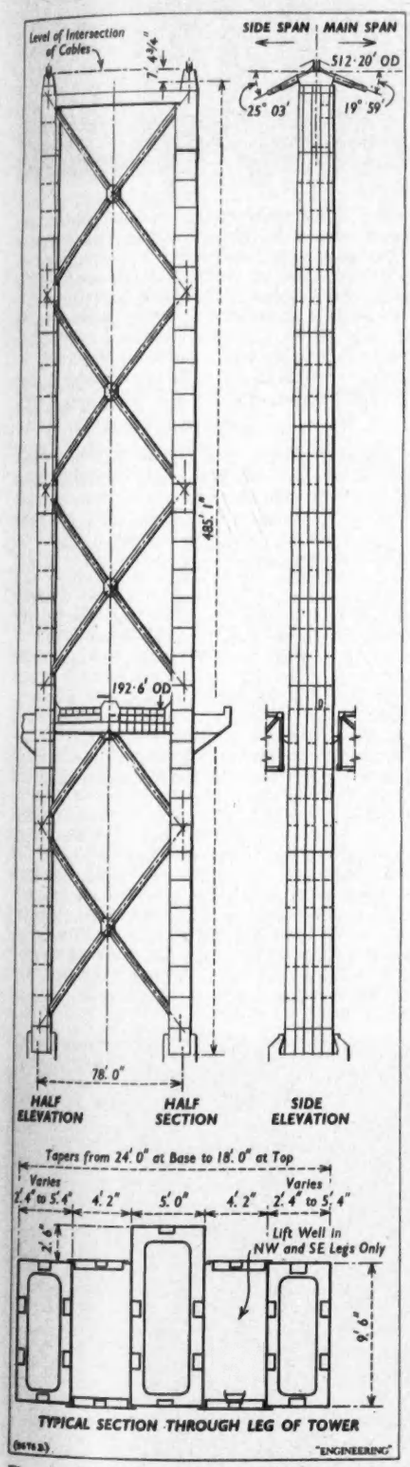


Fig. 7 Tower dimensions and typical cross-section of one leg showing the three boxes and the cover plates.

Erecting the Main Towers

Fundamental to the design of the towers was the method of erection, using a climbing structure which provided a completely safe working area at all levels. Grip bolts are being used to make most of the site connections.

With such a design of tower and method of fabrication as has been recounted, the importance of correctly setting the bottom members or base of the towers upon their proper footings will not go unappreciated.

The bottom members, those for the north tower are shown in Fig. 6 and in position in Fig. 8, differ from the rest of the tower steelwork in that they are made of mild steel. They have the same form of five cells, but of their full height of 12 ft 7 in, 10 ft is buried in the concrete of the pier. The numerous T-brackets on the sides of the members ensure good bonding with the concrete and the moment of the holding down bolts is increased by the three brackets on both sides of both legs of each tower. Altogether there are 56 holding down bolts for each leg. The bolts, 2¾ in in diameter and of high tensile steel, are 15 ft long, 13 ft of which are set in the heavily reinforced concrete.

The base member was set on steel packings about 6 in above the concrete pier, then aligned and levelled. Dry concrete was put below the base and rammed home. After a period allowed for curing of the concrete, the bolts were tightened to give them a prestress of 60 per cent of their yield stress.

The bottom lifts of the legs were erected by a 32 ton Henderson derrick which was subsequently used to unload the other steelwork and place it ready for lifting into position by the crane on the climbing structure.

To provide power for the cranes, lifts and lighting, an 11,000 volt supply has been provided to 500 kVA transformers and distribution boards located at the foot of both towers on the pier stagings. In addition, compressed air and water supplies have been laid on. Cross river transport, in the form of several launches, has been provided to give regular connections between the south bank, where the site offices and stores are located, and the north shore. Radio-telephones are installed on all the river craft and at strategic points on the site to assist control of the work.

The climbing structures were basic to the design of the towers. There is one for each tower and the description of one applies equally to the other. They consist of a rectangular structure of box members which form working platforms surrounding the twin legs of a tower, as shown in Figs. 9 and 10. They carry all the paraphernalia required for the erection of the towers: a 32 ton Henderson crane able to hoist and put into place all the steelwork; gantries and bolting up cages that give easy access to all points on the towers with absolute safety; and the hydraulic pumps and jacks, with their associated control gear in a separate cabin, required to raise the structure as erection of the tower progresses. The climbing structure, giving all reasonable protection from the weather, thus formed a comprehensive working platform, equipped with all the tackle and plant—compressed air, water—necessary to building the towers. The men spent the whole of the working shift there, meals were sent up and some cooking was also done up there. Access for men and small gear was by temporary lifts built on the outside of the towers. A microphone-loudspeaker system made communication possible during jacking operations.

The Henderson derricks on the climbing structures are of special design, with separate electric motors for hoisting, derricking and slewing. The motors for derricking and slewing are mounted on the crane mast while the motor and machinery for hoisting are mounted remotely on the climbing structure. The full load of 32 tons is lifted on a single part rope and hook and the hoisting drum is suitably grooved to carry the coiled rope in one lap for the full height of the lift (over 500 ft). The jib length, centre to centre, is 85 ft and the minimum radius of operation 17 ft.

The 60 hp motor used for hoisting gives a speed of 16 ft per min when raising 32 tons, but a change speed gear is provided that will give a much higher speed (53 ft per min) for loads of 8 tons or less. With full load, the derricking speed is 20 ft per min and the slewing speed 58 ft per min at the maximum working radius of 55 ft. The maximum arc of slew, again at full load, is 180°.

The climbing structure weighs 240 tons and it is raised by eight 100 ton jacks, which have a travel of 18 in. To raise the structure, its weight is transferred to four hanging links suspended from a crosshead placed over the top of the erected tower; these links are seen clearly in Fig. 10, which shows the structure ready to be raised to the top of the third lift for the further erection of the tower. The pins used to fix the structure to the links are shown in Fig. 11. As may be deduced, the jacks raise the structure 18 in at a time, until the new working height is

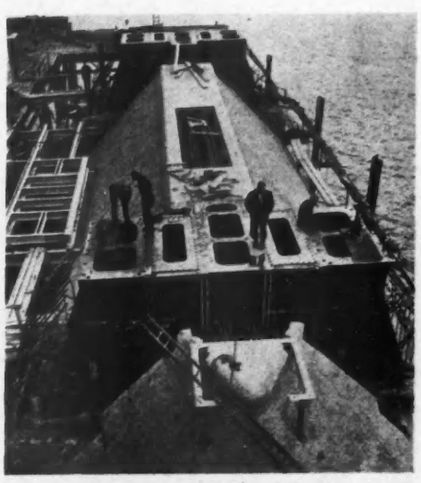


Fig. 8 The feet of the tower in position. On the correct setting of the feet depended the plumbness of the 500 ft high tower.

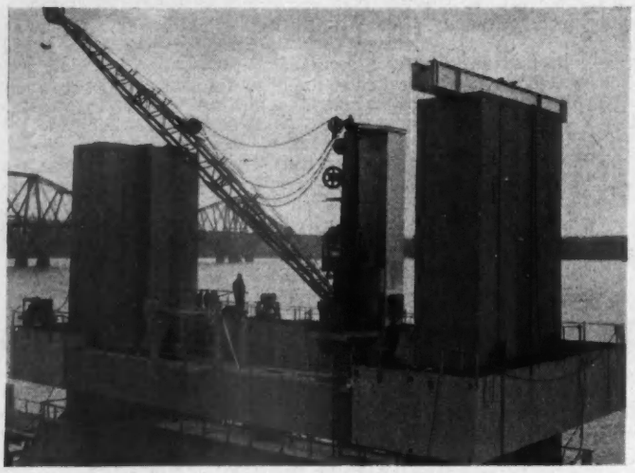


Fig. 9 (Left) The climbing structure which formed a safe working platform at all stages of the tower erection. Its use was basic to the design of the towers.

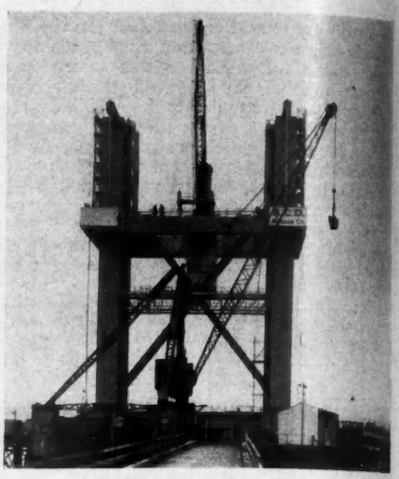


Fig. 10 (Right) The climbing structure ready for lifting to a higher stage. The erection cages are clearly seen.

reached; there the structure is re-fixed to the tower by supporting plates which engage with plates welded on to the sides of the towers. These plates on the towers can be seen in Fig. 9; because of the crane, the climbing structure is not balanced, hence the two plates on the near side of the tower to prevent overturning. One of the supporting plates on the climbing structure is shown in Fig. 12; this illustration also shows a corner guide which further assists with holding the structure in place. With the new level attained, the crossheads are removed (though the links are left hanging below the structure) and the next boxes are lifted into position.

GRIP BOLTS

Good location of a new box is first made by two dowel pins fitting in holes in diagonal corners of the machined interfaces of the boxes. The main contribution to the strength of the joint is then made by a series of holding down bolts around the periphery of the joint. They are tightened as they are inserted and then have to be systematically retightened as increasing loads put into the tower cause them to slacken. In addition to the main holding down bolts there are also a number of ordinary grip bolts helping to make the joint. All this bolting is required only to joint the tower as a free standing mast during the construction period; with the cables and decking in position, the dead loads will generate a compression in the towers that could make the bolting between successive lifts theoretically unnecessary.

Close fitting bolts obtained from S. Marsden and Sons—not grip bolts—at 6 in centres have been used to fix the cover plates which, with the three boxes, complete the five-cell form of the tower legs. Connection of the cross bracing, which fixes to the protruding centre box, is all by grip bolts which are being used for making most of the site connections of the bridge. The grip bolts are of $\frac{7}{8}$ in diameter and are put in $\frac{15}{16}$ in diameter holes. Consolidated Pneumatic impact wrenches—model 610 working at 90 lb per sq. in—are being used to tighten both the fitted and grip bolts, the former to 490 lb-ft and the latter to a higher figure by taking them up to 490 lb-ft and then giving one extra full turn to take the bolt beyond the yield point.

The grip bolt specified for the Forth Bridge is the Gilbert Roberts bolt, nut and washer assembly made by A. P. Newall and Company Limited of Glasgow. This bolt unit is shown in Fig. 13. The bolts are of 65/75 tons per sq. in alloy steel, heat treated and cadmium plated. Their design is such that the body of the bolt is reduced to a diameter below that of the thread root so that on tightening the stress is distributed over the waisted portion and a considerable degree of stretch is obtained.

Because of the heavy crushing pressure exerted on the underside of the nut, the standard type of nut is unsuitable and a combined nut and washer has been developed to produce a smooth rotation during the tightening cycle. The nut bearing face is located towards the centre of the nut's threads. This arrangement successfully transfers the heavy stress from the two leading threads and distributes the load evenly throughout the threaded portions, allowing maximum bolt loacing to be obtained without seizing or stripping of the nut. Briefly, the nut has a collar facing towards the head of the bolt and the washer slips over the collar and is tightened in this position. It was at one time feared that bolted connections would tend to slacken under repeated load but, with this arrangement, it is claimed that these bolts can be so tightened as to reduce the need for replacement to a minimum.

The first tower section, the footing for the north tower, was taken to the site and erected in June, 1960; the north tower was completed on schedule in February of this year; erection of the south tower began in November last year and is due for completion early in May. After erecting the first lift, six weeks were required for building the climbing structure and then a further 17 weeks were taken up with the erection of the remainder of the towers.

EXPOSED POSITION

The top of the tower is completed by a cross member (which has been the temporary front beam of the climbing structure) and by the cast steel cable saddles that have been made by William Beardmore of Glasgow. Before the climbing structure is dismantled two 10 ton electric derricks will be taken to the top of each tower to be used in raising temporary catwalks and cable spinning equipment, and lowering the unwanted sections of the climbing structure.

These derricks have 50 ft jibs and are of the two-motor type, made as specials by Butter Brothers and Company Limited of Glasgow. They are described by Butters as being made exclusively of the normal stays and sleepers (sometimes called racking and lying legs) but constructed so that, at a future date, the ancillary equipment can be supplied to convert them to standard machines. The cranes were specified to lift their full load of 10 ton at 37 ft 6 in radius from 510 ft below the soleplate at a speed of 42 ft per minute, but with a change gear making it possible to raise 2½ ton at 160 ft per minute. They are also fitted with a modern cabin situated well forward so that the operator will be able to see the hook at the full extent of the 500 ft lift.

The site is, of course, extremely exposed, particularly at the top of the towers. To prevent

Fig. 11 (Left) Two of the 100 ton hydraulic jacks that raise the climbing structure, a lifting link and holding pin.

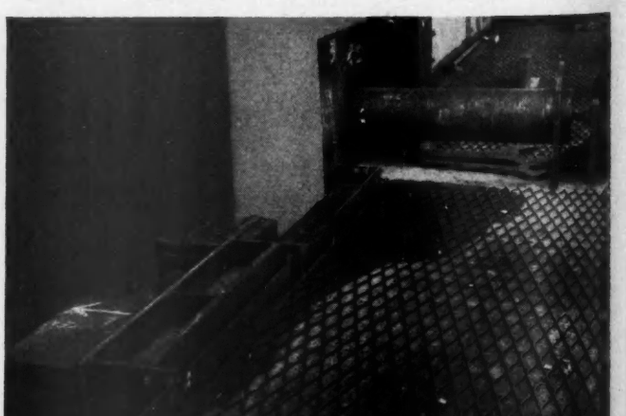


Fig. 12 (Right) One of the supporting plates used to clamp the climbing structure to the tower and a corner guide.

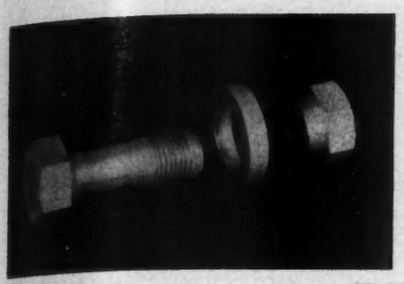


Fig. 13 Most of the site connections are made with Gilbert Roberts grip bolts. Their use is basic to the design.

steelwork that was being raised from being blown against the tower, taut ropes have been provided down the line of lift. Fortunately, the last winter has been relatively mild and work has not often had to stop because of bad weather. Even though the crane on the climbing structure was required to be lashed if the wind speed exceeded more than 25 mph, the number of occasions this has been necessary has been insufficient to delay the construction programme.

Lubricants used inall the plant—cranes, compressors—were selected from among Shell and BP products for their ability to work in cold weather. Another point that had to be watched in this respect was the brake hawsers on the temporary lifts on the outside of the towers. The arrangement was such that if the lifts began to fall too quickly brake shoes would automatically clamp on to the hawsers. Had the hawsers become first wet and then frozen, ice might have collected on them and prevented them functioning. To prevent ice forming, a Shell anti-freeze solution was put on to the hawsers by a wick feed—and no trouble was experienced in this respect.

On such an exposed site, temperature effects on the completed bridge are liable to be considerable. Movements in the deck are taken up at the main towers, the main span and two side spans being three separate structures hanging independently from the cables. To accommodate the movements, the ends of the stiffening trusses are supported by links able to swing in the length of the deck and carried from brackets at road level on the towers (Fig. 14). The arrangements made for temperature movements are amplified on page 454.

Fig. 14 (Right) The top lift being put into place on the north tower. The temporary lifts can be seen on the outside of both legs.

Spinning the Cables and Hanging the Deck

The Forth bridge will be the largest cable spinning operation undertaken outside the United States. Synchronised drives will be used for the reels and travelling sheaves. The suspenders, of a new pattern, are being made true to length, without incorporating an adjustment device.

All the wire for the main cables—7,500 tons in all—is being drawn in plant commissioned for the purpose by Dorman Long at Middlesbrough. Drawing commenced about 18 months ago and will be completed within the next two months.

The wire, which is galvanised, is of high tensile steel having an ultimate tensile strength of 100 to 110 tons per sq. in. It is 0·196 in in diameter, a diameter that has long been established for this type of work as representing an optimum between the strength of the wire and the length of wire required: by drawing the wire thinner, a higher strength could be obtained but a greater length would be required; alternatively, a larger diameter would mean a lower strength and a stiffer wire that would be more difficult to bend round the pulleys and reels.

Possible corrosion of the wire during storage has been prevented by keeping the coils (weighing up to 10 cwt each) in stacks sealed within polythene bags in which the air is conditioned by Westair dehumidifying units.

About 30,000 miles of wire are required for the Forth bridge and it will be taken to the site by rail and put into a reeling store built on the south bank. There the coils will be spliced together and wound on to 7 ft diameter reels ready for spinning in place to form the cables. The splice is a mechanical joint made by swaging on to the ends of the wire in a portable press a tough steel sleeve of 0·400 in diameter containing two hardened and threaded inserts. This method of jointing high strength wire was devised, and the equipment supplied, by Cable Covers Limited.

Before spinning can start two temporary catwalks have to be erected a few feet below the final level of the cables, starting from the anchorages and passing over the main towers and the side towers. Work on these catwalks is expected to start in June and to take until the end of August to complete. Each catwalk will be supported by ten 1 in diameter wire strands which will be towed across the river and layed on the bottom by pontoons. At slack water over a period of about three weeks (shipping traffic is mainly at high tide) the strands will be raised into position by the Butters cranes built on to the top of the towers.

The two catwalks, each 9 ft wide and with wire parapets 3 ft 6 in high, will be connected by seven cross bridges—five in the main span and one in each side span—and a system of wire rope storm bracing will be erected to keep them secure against winds of gale force. A series of "goalposts" will be built at 200 ft centres which will carry the tramways for spinning the cables about 15 ft above the floors of the walkways.

The contract for all the temporary ropes and strands, for the catwalks and tramways, and also for the permanent suspenders, was awarded to Bruntons (Musselburgh) Limited of Musselburgh, near Edinburgh. Apart from the suspenders, described below, nearly 800 miles of wire have been used in the temporary strands; all of them were preloaded to about half their ultimate load on the firm's prestressing range to remove, as far as is practicable, non-elastic stretch. The longer strands for the catwalk and the tramways, all around 6,000 ft long, were also preloaded to their working loads and marked to ensure correct erection.

It is the first time that spinning of suspension bridge cables has been undertaken on this scale outside the United States of America and advice on the design of equipment, as well as assistance with the site supervision, is being obtained from John A. Roebling and Company, Trenton, New Jersey, USA, the firm who originated the method and who have had so much experience on the great American suspension bridges.

The method to be adopted for spinning the main cables is shown in the accompanying diagram, Fig. 15, which relates only to one main cable, the whole system being duplicated for the other. Basic to the system is the endless hauling rope carrying two travelling sheaves, one of which will cross the river hauling new wires behind it as the other returns empty. Each sheave has four grooves so that it will carry four loops or bights of wire at a time (for clarity, only one bight is indicated). Wire for each bight will be fixed by one end into the anchorage, looped over the sheave and the wire required as the sheave moves forward will be obtained from reels mounted above the anchorages. Haulage speeds of 700 ft per minute will be achieved and to make this possible the reels and the haulage drive will be powered by synchronised electric-hydraulic drives. The tension in the wire will be kept constant by passing the wire through a counter-weight tower as it leaves the reels. All the cable spinning will be initiated from the south bank.

During the spinning process, men will be

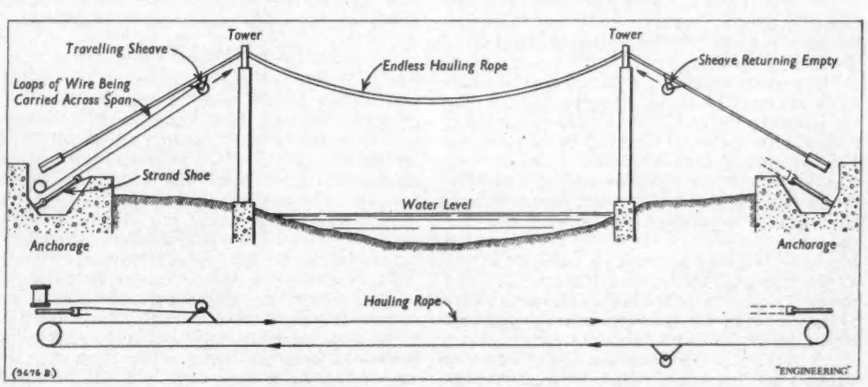


Fig. 15 Cable spinning: loops of wire, four at a time, are dragged across the river by an endless haulage rope at a level close to their final position. The sheaves will travel at 700 ft per minute.

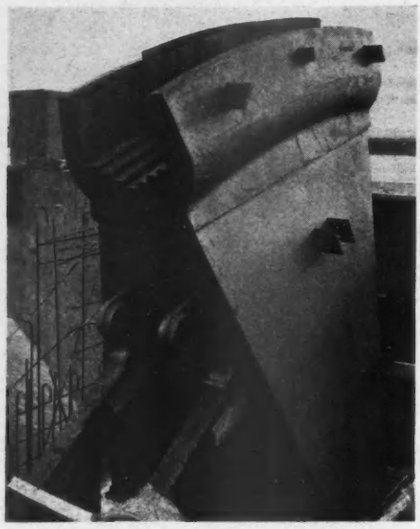


Fig. 16 Saddle for the north side tower, showing the grooves in which the separate strands of the cable bed down.

stationed at 200 ft intervals along the full length of the catwalks and it will be their duty to adjust the wires as they are deposited against a fixed guide wire, so ensuring that all the wires have the same calculated sag. Emergency stop buttons along the catwalks will enable the men to stop the operation if it is getting out of hand. The speed of the sheave—700 ft per minute—is about 6½ mph and is just about as fast as is practicable for the men to keep up with over their alloted spans. At this speed, and allowing for halts, eight wires each 7,000 ft long will be put into place in 18 minutes.

The work of spinning, due to start in September, will usually be carried out in two "day" shifts. Completed strands will be adjusted for length, using jacks at the towers and anchorages, and laid into their final position in the cable during the night. Night time is chosen for this work of adjustment because then the temperatures of the wires are more likely to be sensibly uniform.

When the whole cable has been put in place and adjusted, the wires are squeezed together to form a compact circular section. This compacting is done by a travelling machine which encircles the cable, and moves along it, squeezing the wires together at intervals of 3 ft by means of hydraulic jacks. After completion, each cable is permanently clamped into position against the machined faces of the cast steel saddles on the top of both the main and side towers. A side tower saddle is shown in Fig. 16. Each cable will contain 11,618 wires, distributed among 37 strands, and the final diameter will be 23¾ in.

The next task will be to bolt cable bands of cast steel at each panel point and over these will be placed the wire rope suspenders that will carry the deck of the bridge.

The suspenders, or hangers, will also be made by Bruntons of Musselburgh and delivery to the site is due to start towards the end of this year. About 2,800 miles of wire will be used in the 192 suspenders, each of which comprises two parts of rope of slightly different length at 7½ in centre terminating in a common socket at each end. Two sizes of rope will be used, the four parts of rope in each suspender developing an aggregate breaking strength of 600 tons in the larger rope and 450 tons for the smaller. The stronger ropes are for use in the side spans where a heavier deck construction is employed and the lighter suspenders for the centre span.

All of the rope for the suspenders will be prestressed on Brunton's range to remove non-elastic stretch. After prestressing, each rope will be preloaded to its working load and cut accurately to length. No means of adjusting the length is incorporated in the deck structure.

The difference in length between the two pieces of rope in each suspender is due to the pieces lying side by side on the bight round the main cable but having to end in the same sockets; the difference in length varies between suspenders according to the position along the cable and the inclination of the cable at the panel point. Brunton's great difficulty is attaching the ends of the two pieces of rope in the same sockets in such a way that the completed suspender is accurate in length to the very close tolerance allowed. Complete suspenders of this pattern have not been made before.

Except for the shortest, the suspenders will be dispatched to the site on wooden reels. They will be wound on to the reels in such a way that the two socketed ends are on the outside for unreeling simultaneously, one socket being lowered simultaneously on each side of a main cable. The lengths of the suspenders vary between 8 ft and 291 ft.

The last operation on the cables, one which cannot be done until most of the deck has been erected, is that of applying a protective coating and wrapping on a layer of 9 swg galvanised soft iron wire at a constant tension of 300 lb.

The actual anchorages, as already noted, were built as part of John Howard's contract. They consist on each bank of two inclined tunnels driven into the rock. The tunnels have been filled with low heat concrete.

The load in the cables is carried from the face of each anchorage through the plug of concrete by 114 wire ropes threaded through steel tubes, fixed at the top and bottom, prestressed in position, and then grouted solid. The prestressing applied a load greater than is to be expected in practice and thereby reduced the movement that can occur at the anchorage face. It is believed that it is the first time that such preloading of bridge anchorages has been used.

At the main towers, the stiffening trusses are hung on pivoted links which permit an outward expansion of 2·77 ft and a contraction about the mean of 3·12 ft; that is, the main span is allowed a total movement of 5·90 ft at each end. The location of these expansion links is to be seen on the elevation of the tower in Fig. 7, and the brackets from which the links will be suspended can just be discerned on the completed north tower, Fig. 14. On the other side of the main tower, a similar linkage supports the end of the side span and here the overall movement allowed is 1·75 ft, being 1·00 ft of contraction and 0·75 ft expansion. At the side towers, the truss bearings are rocker columns, 8 ft 5 in vertically between pivots, supporting the top end panel points and permitting corresponding movements. Roadway expansion joints (or, more strictly, deflection joints), employing conventional steel comb plates, will be used at the side towers, but at the main towers, where the possible movements are much larger, a train of overlapping leaves of non-slip mild steel plate on rollers, moving in and out of a gap in the deck, are employed.

In the main span, to reduce weight, the roadway is designed as steel "battle decks"—steel plates stiffened by troughing and carried on stringers, as shown in the half-section of Fig. 17. The top wearing surface is a comparatively thin layer of asphalt. Within the spacing of the main trusses, there are two 24 ft carriageways, divided by a marginal strip 10 ft wide. Outside the line of the trusses are the cantilevered cycle track, 9 ft wide, and the 6 ft wide footpath.

In the side spans, where the saving in weight is of no advantage, the roadways are of cheaper composite construction, as shown in the other half-section of Fig. 17, consisting of reinforced concrete slabs which act in conjunction with the steel stringers to which they are bonded by shear connectors.

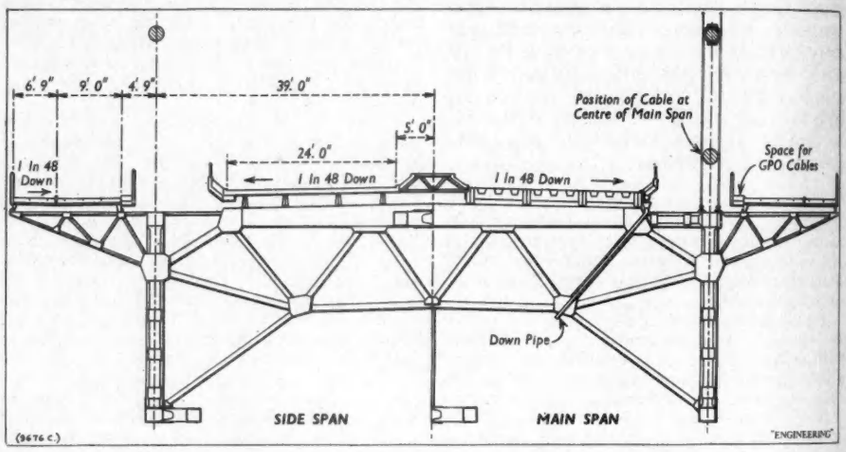


Fig. 17 Cross-section of the bridge deck; on the left is the deck of the side spans and on the right the lightweight battle deck of the main span.

DECK STRUCTURE

The deck structure, as in most long span suspension bridges consisting of an open framed box, comprises the deck itself, the principal stiffening girders in the form of Warren trusses at 78 ft centres and 30 ft deep, lattice girders at the panel points (60 ft centres) and the lower boom cross bracing. The trusses and their bracing have the duty of stiffening the long freely suspended decking and preventing undue distortion either sideways or vertically due to traffic or wind loading.

Expansion in the deck structure is taken up on each side of the main towers, the main span of 3,300 ft and the two side spans each of 1,340 ft being three separate structures suspended independently from the cables. The main span is able to expand in both directions and the sides spans are held at the side towers and expand only towards the main towers.

All the steelwork for the decks will be delivered by road to the foot of the main towers, making use of the contractor's temporary causeways. From the foot of the towers the steelwork will be raised to deck level and erected by four 15 ton Henderson electric derricks which will travel away from the towers, placing the steel in front of themselves as they go. Thus the deck will grow in both directions from the two main towers simultaneously, so that some degree of symmetry is obtained between the loads being applied to the main cables. To prevent undue distortion of the cables, the cranes will erect the steelwork in the main span in two passes and connections between the panels of the stiffening trusses will only be made as temporary distortions are eliminated. Throughout construction of the deck, safety nets will be suspended below the working area.

The total suspended steel in the decks is 16,000 tons.

Neutron Economy

NUCLEAR industry is now going through a period of reassessment after the initial enthusiasm springing from the appreciation of the potentialities of nuclear power. Now countries tend to concentrate on one or two systems and develop them to be as efficient as possible, instead of attacking on a broad front. Once nuclear power has been proved to be economic by power stations that actually produce electricity on a commercial basis then the industry will take a "shot in the arm" after this present period of consolidation. It will not be until this time that nuclear power will establish its position as a power producer; as it becomes competitive so will interest be fired again. Meanwhile, many firms now find that it has not been a remunerative venture and are either forfeiting their position or watching future developments without committing any more capital.

Coated Particle Nuclear Fuel

A three-year research programme on the "coated-particle nuclear fuel concept" is to be executed by the Battelle Memorial Institute under a contract from the USAEC. The objective is to develop coated particles with high temperature properties, fission product retention capability, and good neutron economy. The programme will also provide much of the fundamental information required in support of the overall Commission effort on coated particles. In the "coated-particle" process, small grains of the fissile nuclear fuel compound are coated individually with a dense, refractory material that will both protect the fuel from damage by chemical reaction at the high temperatures of the nuclear reactor and prevent escape of the troublesome radioactive byproducts formed in the fuel by the fission process. Both carbon and alumina coatings have worked well in early tests conducted at Battelle in work related to the pebble-bed reactor concept. After coating, the fuel particles are evenly dispersed in a material, such as graphite, which can be conveniently shaped into reactor fuel elements by mass production methods. Such a fuel appears particularly attractive for high temperature operation because only non-metallic refractory materials are utilised. Good neutron economy can also be expected from coated particle fuels.

Plutonium Recycle in the Gas Cooled Reactor

Three possible schemes for recycling plutonium in the Calder Hall type of reactor together with the economics and physics have been described. The schemes are developed on the assumption that the burnup is 8,800 MWD per tonne, since this figure is expected to be realistic in the future. For the first scheme the plutonium produced in a run is blended with fresh natural uranium for a subsequent run; in the second the plutonium is alloyed with some diluent metal and fabricated into high heat-transfer elements similar to the MTR or PWR seed-type elements and a subsequent load of fresh natural uranium elements is "spiked" with these plutonium elements; in the third scheme half the spent uranium is recycled as well as the plutonium. The conclusions are that the first scheme will be the most economic means of recycle and will compete very favourably with the mode of operation where the plutonium is sold at the end of each run for $12 per gm. ("Plutonium Recycle in the Calder Hall Type Reactor," L. J. Barbieri *et al.*, *Nuclear Science Engineering*, vol. 5, No. 2, 105-19.)

New Value of Carbon 14 Half Life

A more accurate value for the half life of carbon 14 has been obtained by the National Bureau of Standards. The new value is 5,760 years, compared with the previously accepted value of 5,568 years. The redetermination was obtained by quantitatively diluting carbon dioxide of high specific activity for counting in length—compensated internal gas counters over the Geiger and proportional regions. Mass spectrometric analyses of parts of the undiluted gas sample were made to determine the isotopic abundance of carbon 14.

Future for Silicon Carbide?

The temperatures anticipated in high-temperature gas-cooled reactors limits the number of materials that are suitable for fuel-element cladding and the internal hardware. Ceramics which have the desired properties are usually thought to be confined to beryllium oxide, silicon carbide and graphite. Although silicon carbide lacks the moderating ability of beryllium and graphite it has other very worthy attributes. Over the operating range of high-temperature reactors it has a high thermal conductivity approaching that of graphite; low thermal expansion, less than the refractory metals; good semiconductive electrical properties; and high strength up

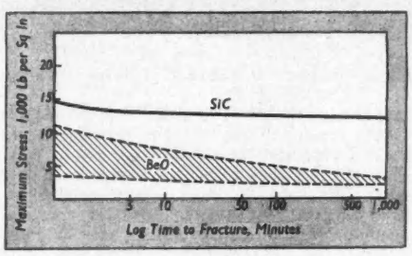


Fig. 1 Maximum stress against time to fracture at 1,400° C for silicon carbide and beryllia.

to 1,500° C where beryllium is undergoing creep. It has low neutron cross-sections but this characteristic is reduced slightly by the impurity boron. A comparison of the load-carrying ability of beryllia and silicon carbide is shown in Fig. 1 and was taken from "Stress-Strain Temperature-Time Relationship for Refractory Materials," by R. D. Chapman (NAA-SR-3205), and shows that at 1,400° C silicon carbide can sustain much higher loads than beryllia. Graphite is still weak at this temperature, but at extreme temperatures it is the strongest of the three materials.

Silicon Carbide Lagging Behind

The amount of research that has been conducted on silicon carbide is small in comparison with that on beryllia. The principal weakness in using silicon carbide is that few companies know how to fabricate dense silicon carbide shapes free from undesirable binder materials. It has little moderating effect and above 1,600° C it oxidises in air. On the other hand beryllia is found to be unstable in moist air, creep at high temperature under sustained load, has a high price and toxicity problems (but it may be fabricated by established techniques).

It contributes to moderation, and has the highest thermal conductivity of all the oxides, giving it good heat shock resistance and heat-transfer properties. Silicon carbide continues to be investigated as a protective coating on graphite where it protects against oxidation and erosion. ("Silicon Carbide for Nuclear Reactors," by Dr. G. H. Butter—presented to the American Ceramic Society.)

Thermal Shielding Materials

The Hiduminium 400 series is a new group of materials for thermal neutron shielding developed by High Duty Alloys. The product consists of boron carbide of suitably fine mesh evenly dispersed in a fully wrought aluminium matrix and clad in both sides with high purity aluminium. This product varies fundamentally from the conventional Boral which is produced by a powder-metallurgy technique and is non-formable. The boron carbide particles vary in size between 80 and 200 mesh, and a method has been perfected by which the particles may be uniformly suspended throughout molten aluminium, followed by semi-continuous casting to a rolling slab which is then clad and rolled in the usual manner. The boron carbide has a purity of more than 90 per cent. Also the new materials have light weight, good corrosion resistance, good conductivity and machinability, stability up to the melting point of aluminium and the ability to absorb thermal neutrons without the production of "hard" gamma radiation.

Neutron Temperature Measurement

The temperature coefficient of reactivity of a thermal reactor is the sum of two components: one associated with the neutron temperature and the other with the fuel temperature. The latter is closely related to the physical temperature of the moderator and is always negative for a gas-cooled graphite-moderated reactor of the Calder Hall type. The neutron temperature component is negative before irradiation but becomes positive after irradiation due to the production of plutonium. The recent practice of including the moderating material in the coolant channel have made the thermal contact of this material with the bulk moderator poor, while that with the fuel element is good. Thus the slow variation of moderator temperature during a fuel temperature transient is no longer fulfilled. A UKAEA report has been published dealing with the temperature of neutrons reaching the fuel element when it is surrounded by a heated graphite sleeve. The neutron spectrum effect of such a sleeve surrounding a fuel element may be separated into the change in neutron temperature on transmission through the sleeve, and the change due to the presence of heated sleeves in all other channels. The experiments were designed to investigate these two effects independently. Changes in the neutron temperature within the sleeve were determined experimentally by changes in the fission rate of plutonium 239 relative to that of uranium 235. ("Neutron Temperature in Reactors having Moderator Closely Associated with Fuel Elements," by R. G. Freemantle and J. S. Harper. AERE-M712.)

Notes and News

"Netherlands Atom Forum"

The Reactor Centre of the Netherlands (RCN) and various Netherlands industrial concerns have founded the Netherlands Atom Forum. The object is to give publicity to the developments in nuclear energy, by means of publications, conferences and meetings, and to coordinate Netherlands' participation in exhibitions.

The Forum will represent the Netherlands in the "Forum Atomique Européenne" (Foratom), which was established in Paris on 12 July, 1960, in which corresponding organisations from other Euratom and non-Euratom countries have been brought together. Mr. W. A. de Haas, secretary of the Industrial Commission of RCN, has been elected chairman of the Netherlands Atom Forum and the secretariat is accommodated in the RCN offices.

Reactor Materials on Loan

The USAEC will lend free of charge Pennsylvania State University the enriched uranium contained in fuel and fission counters for the University's research reactor. The Commission will also provide for the reprocessing of the spent fuel. The Curtiss-Wright Corporation of Woodridge, New Jersey, presented the reactor to the University in September, 1960. The reactor is a light water moderated and cooled pool type, and can operate at power levels up to 1 MW(t). A 200 kW(t) pool type research and training reactor has been in operation at the University since August, 1955.

Assistance similar to that made available to Pennsylvania State University has been given

to North Carolina State College, University of Michigan, University of Virginia, Washington State University, Massachusetts Institute of Technology, Texas College of Agriculture and Mechanics, University of Buffalo, and Georgia Institute of Technology

It would be encouraging to see the United Kingdom Atomic Energy Authority making a similar gesture to educational institutions in Britain, to replace the present complicated and frustrating system for obtaing uranium on loan at the Authority's high charge.

Nestor Goes Critical at Winfrith

The 10 kW (th) reactor, Nestor (Fig. 2) went critical at the Atomic Energy Establishment, Winfrith, for the first time on 13 March, 1961. The reactor is a modified Jason, supplied by the Hawker Siddeley Nuclear Power Group, and it can drive up to five sub-critical assemblies simultaneously. (Atomic Review, 30 Sept. '60 and 18 Nov. '60.) These assemblies will be used to provide experimental data for graphite, natural water and heavy water moderated power reactors. The reactor has a maximum flux in the centre of the core of 10^{11} neutrons per sq. cm per second and 10^{8} neutrons per sq. cm per second in the sub-assemblies. The thermal flux level in the sub-assemblies may be altered by three methods: changing the power level, using neutron shutters and rearranging the fuel loading in the annular core (Atomic Review, 28 Oct. '60). The fuel elements are the MTR type and control is governed by cadmium rods or varying the level of the water in the core.

Reports Received

Material Effect on Criticality: The density of hydrogen and uranium in crystalline solids and liquids which may occur during processing of fissile materials are given. The density of the moderator and fissile material in a system have a profound effect on the criticality. (" Densities of Hydrogen and Uranium and their Effect upon Criticality," by E. V. Garner and K. D. B. Johnson. AERE—M 718.)

Absorption of Resonances: Using the well verified form of the resonance integral in uranium metal for uranium spheres and rods, the resonance intergral has been determined for the cases where scattering of the neutrons is important. The method leads to a more general result than the approach of Gurevich and Pomerachouk. (" Resonance Absorption in Heterogeneous Systems," by G. Memmert. AERE—Trans. 853.)

Plutonium Hardness Testing: Increasing use of plutonium and its alloys and the need to investigate their mechanical properties at high temperatures has made it necessary to design equipment for alpha active research work dealing with temperatures up to 1,000° C to determine their hardness and tensile properties. (" Apparatus for Determining the Mechanical Properties of Alpha Active Materials," by M. J. Notely and P. M. French. AERE—M796.)

Beta Emission: A system has been devised for the measurement of the average energy of a beta emitting isotope at room temperature in micro-microcurie amounts. A mixture of two beta-emitting isotopes may also be selectively counted in a single sample if the difference between the two energies is sufficiently large. (" Identification of Beta-Emitting Isotopes by Liquid Scintillation Counting," by W. P. Hutchinson. AERE—R 3605.)

Bibliographies[5] A bibliography has been prepared of the published reports, papers, journal articles and patents for the oxides of Europium, Gadolinium, Praseodyium and Samerium (AERE Bib. 130). A further bibliography has been compiled for uranium carbides with references up to the end of 1959. (AERE Bib. 129.)

Controlling the Flow of Mercury: Full constructional details are given for a mechanism giving simultaneous detachment of mercury drops from two dropping mercury electrodes. Some theoretical considerations of the design are also shown. (" Device for the Synchronisation of Two Dropping Mercury Electrodes," by W. H. Lockwood. AERE—R 3521.)

Overcoming Inaccuracies: To eliminate the inaccuracies of obtaining gas pressure distributions from magnetic field measurements when applied to a system with toroidal symmetry, a different method is proposed involving the direct measurement of current density using a Rogowsky coil. (" Measurement of Pressure Gradient in High Current Discharges," by M. G. Rusbridge. AERE—R 3578.)

Transfer System: Equipment has been designed using standard relays and uniselectors to transfer digital information, originally stored on a ferrite matrix, from transistor trigger circuits on to perforated tape. (" An Automatic 1,000 Channel Read-Out System," by R. L. Elliott. AERE—R 3291.)

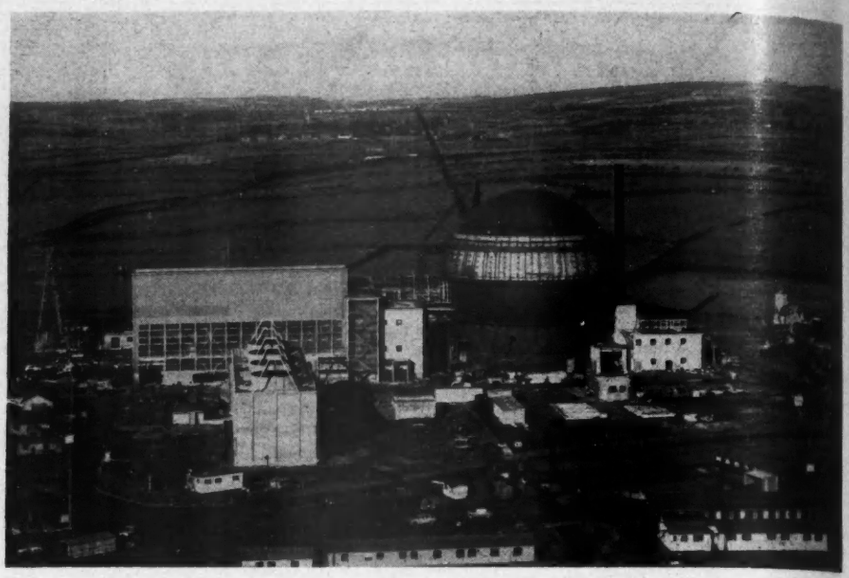


Fig. 3 Progress at Windscale showing the cooling towers (left foreground) and the completed sphere.

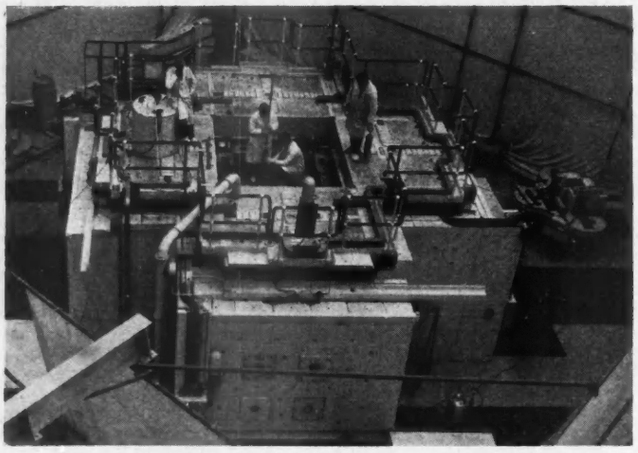


Fig. 2 Loading a fuel element into Nestor during the initial approach to criticality.

Reactor Notes

Organic Reactor: The USAEC has received nine expressions of interest from cooperatively and publicly owned utility organisations to participate in a 50 MW(e) organic cooled and moderated reactor which is expected to act as prototype to a larger model.

Reactor Site Criteria Guides: The USAEC has issued for public comment a " Notice of Proposed Guides " containing criteria to guide the Commission in its evaluation of proposed sites for nuclear power and test reactors. The objective of the guides is to keep the exposure of individuals to radiation to a minimum in the event of an accident; they have been prepared by the Advisory Committee of Reactor Safeguards.

Buffalo University: A licence for the operation of a 1 MW(t) research reactor is to be issued to the University of Buffalo. The pool type reactor has been built by AMF Atomics, Inc., and will be cooled and moderated by light water.

Project Terminated: The USAEC has decided that the proposals submitted in response to an invitation to cooperatives and public power organisations to participate in a small 15 to 20 MW(e) pressurised water reactor plant are unacceptable and has decided to terminate the project. Initially the sites offered by two proposers were not satisfactory from the safety aspect. In response to the Commission, alternate sites were offered which were considered adequate, but these introduced adverse changes to the original proposals and greatly increased the costs of the estimates, making the plant uneconomic.

US Fuel for Turkey: 2,500 kg (5,500 pounds) of natural uranium fuel have been shipped by the USAEC to Turkey for a subcritical assembly to be used for research and training at Ankara University. Some of the students will be transferred to carry out programmes on the research reactor now under construction in Istanbul.

Spain: The Centrales Nucleares del Norte has applied for authorisation to establish a nuclear power plant at Valle de Tobalina, in the Province of Burgos. The plant, to be known as Bilboa-Ebro, will have a capacity of 250 MW and will cost about £18·7 million.

Companies

105 Years of Selling Machinery to Russia

A COMPANY which first made trade visits to Russia in 1856, and kept them up ever since, is worth special attention. MATHER AND PLATT, the Manchester engineers specialising in the design and development of high quality machinery, are able to point out that from their parent company's total production last year 40 per cent was exported. If the subsidiaries are included in the calculation the proportion rises to 50 per cent.

Turnover for the group last year was the highest in the long Mather and Platt history. But the consolidated trading profit declined from £1,522,972 to £1,316,774. After providing for taxes, depreciation and certain other headings, the profit was £691,876 against £850,751 in 1959.

The changed position is largely explained by smaller profit margins, adopted in order to meet increased competition in the home and overseas markets. Evidently they have not been accepted without results, for the volume of orders received in 1960 was a record.

Relating the success in export markets to the prosperity of the home sales, the company find that the textile industry continues to improve but they are having the same difficulties in the electrical and pump departments as are met by other companies in the same fields.

The contact with the Soviet Union has in more recent times than 1856 yielded contracts for complete canning lines and the equipment for a new tyre factory at Dnepropetrovsk. Paying equal attention to the efficiency of management operations, the company have developed a new contracting department which handles package deals for comprehensive installations. This department prepares tenders, accepts and confirms orders of this type and sees the contracts through to completion.

Mather and Platt's 7,000 labour force produce a range of machinery from textile finishing and plastics equipment to electric motors and generators, centrifugal pumps, food processing and packaging machinery, as well as fire engineering equipment.

Establishing Motor Cycle Exports in the USA

The divided state of the market in motor cycles has the result for ASSOCIATED MOTOR CYCLES that at the heavier end of the range, its Matchless, AJS and Norton machines have been selling increasingly well; also the proportion of exports has appreciably increased. A much less happy situation exists among the lightweights and some anxiety for the future is expressed by the AMC chairman, Mr. D. S. Heather.

Following the heavy impact of the credit restrictions on the sales of light motor cycles the group made a vigorous attack on the price levels, and carried out considerable rationalisation and reorganisation of production. Substantial cost reductions were brought about and these are to be reflected in the price to the public in the immediate future.

Overseas, Associated Motor Cycles has a newly established subsidary, the INDIAN Company, operating in the United States. More than £250,000 has so far been invested in this new departure, much of it involved with the supply of motor cycles through the shipping and distribution system to points of sale throughout the market. Comprehensive stocks of spare parts have now been built up in East and West coast centres.

Although the Indian Company made a rather heavier trading loss in its first year than expected, only eight months of the year was spent in active business, and it reached its planned sales target. A significant increase in sales is planned for the current year.

At home the group trading profit for the year, excluding the United States subsidiary, was £471,476, compared with £291,842 in the preceding year. In the five months from September, 1960, to the end of this January the group's turnover was about five per cent down on the same period 12 months earlier. The essential weeks for Associated Motor Cycles are in the spring and early summer selling season. Not until then will it be possible for the company to tell with any accuracy the effect of the slight relaxation in the credit restrictions.

New Rates Blow to Shipyard Competition

Heavy new assessment of rateable value, coupled with the recent 4½ per cent wage increase and last year's reduction to the 42 hour working week, means a total addition of at least £30,000 to the cost of a new tramp steamer's hull from the yards of CHARLES CONNELL AND COMPANY, the Scotstoun, Glasgow, shipbuilders.

Mr. C. R. Connell, a director of the shipyard, has explained: "The announcement by the City Assessor that the rateable value of our shipyard is to be increased from £2,323 to £20,400 has come as a serious shock. Even assuming that Glasgow's rates are reduced from 26*s* 11*d* to 23*s* in the £1, it will add £20,000 to our annual costs."

The proposed abolition of industrial derating in 1963, if carried through, will double the assessment of the Connell yard to £40,800. The increased rates plus the 10 per cent rise in electricity charges of the last six months would between them add £10,000 to the cost of a new tramp hull.

"In the face of extreme difficulty, my firm booked new work recently at fixed prices which do not include these increased charges," added Mr. Connell.

The sharp rise in the direct costs of the hull is by no means the only trouble. Some 40 per cent of the total cost of the ship is accounted for by the hull alone. The rest includes the propelling machinery and other materials. All of which are obtained from sub-contracting firms in the Glasgow area who will be meeting proportionate increases.

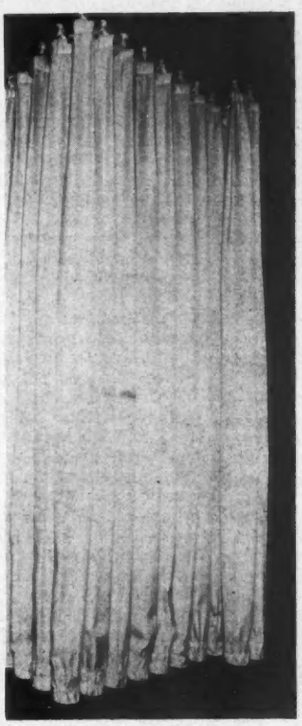
What all this amounts to is that, in future tendering, shipyards affected by substantial revaluation will be that much less competitive. In cases where contracts have been secured at fixed prices that leave almost no margin of profit there will instead be losses.

It is also worth recalling that, in addition to the increased labour costs, the employers' share in the National Insurance contribution is to go up by 41 per cent.

For Connell's, something of the effects of the month by month additions to the costs are perhaps shown by the solemn fact that of 50 shipbuilding contracts placed recently by Norway, not one has been placed in Great Britain. Over the last ten years Norwegian orders have accounted for half the company's output.

£500,000 for Soviet Dust Collection

Eight dust collecting plants for a car factory being built in the USSR at Dnepropetrovsk and for other Soviet factories are to be made by TILGHMAN'S Limited, a member of the STAVELEY GROUP of companies. The TECHMASH



trading corporation signed the £500,000 contract in Moscow.

The plant will be used to purify the hot exhaust gases from carbon black production units. The cleaning is done by passing the dust laden gases through tubular "stockings" of silicone treated fibreglass cloth able to withstand high temperatures. Mr. B. J. Squires, the Tilghman dust and fume control division manager who conducted the negotiations in Moscow, has calculated that some 30 miles of the filter stockings will go into the eight plants.

Other European contracts which the Altrincham company have finished or are nearing completion are in Rumania, France, Czechoslovakia and Italy. Two new fabrication shops being built by the company at their headquarters for this type of product will be finished in time to assist in the completion of the Russian order by January, 1962.

Each fibreglass filter stocking shown in the picture is 10 ft 6 in long and 5½ in in diameter.

Copper Prosperity and International Influences

The copper producing companies are sensitive alike to the influences of the situation in the Congo, the developments in Northern Rhodesia and the level of demand in the industrialised nations, particularly to a possible recovery of activity in the United States.

All these outside factors bear on MTD (MANGULA) Limited, the Southern Rhodesia mining company, whose chairman, Commander H. F. P. Grenfell, outlines in the annual report his reasons for holding a confident view of the future.

In the year just past the copper producing industry has suffered not only from outside influences but from the gradual cumulative establishment of a situation of over capacity. This helped to lead to a downward trend in copper prices continuing well into the current financial year.

The major producers have announced cuts in output. Commander Grenfell observes that it still remains to be seen whether these steps will be effective in restoring stability.

Looking to the future, the MTD chairman believes that with the passing of time the consumption of copper will steadily rise as more and more people come to enjoy higher standards of living. Unless large new deposits are discovered the purchasing power of all the people so affected, in addition to the normal annual increase in comsumption, could produce a demand for copper which the industry would find it hard to meet.

One of the factors more within the control of the copper managers than foreign demand is their own costs of production. In MTD the operating costs, which were 25*s* 3*d* for each short ton of ore treated in the previous year were last year reduced to 20*s* 5*d* per ton. Productivity per employee, both European and African, rose substantially, the tonnage hoisted per employee at work was 40 per cent greater than in the previous year. The increased scale of operations was responsible for much of the improvement.

A Swift Double in ICI Polypropylene

Four months from the opening of their new polypropylene plant at Wilton, in north-east Yorkshire, IMPERIAL CHEMICAL INDUSTRIES have decided to double the capacity, building extensions which will raise the output from 11,000 tons to 22,000 tons a year.

Marketed by ICI under the brand name Propathene, the principal outlet for ICI polypropylene has been for applications in the moulding field, drawing on its high rigidity, high softening point and low density. Users of the material see its future in such diverse functions as car parts, in luggage, television sets and washing machine components, spin driers and refrigerators. Surgical equipment and toys are also on the post.

Another field of possible applications is in large containers, such as cisterns, manufactured from polypropylene in sheet form. Film and fibre applications are also being developed by ICI and substantial tonnage of the material is expected to be absorbed in uses based on these forms.

CONSTRUCTORS JOHN BROWN, the builders of the original plant, will be responsible for the extensions.

Layshaft Gears Produced Automatically

Standard machine tools, connected together by standard transfer devices, provide a cheap, reliable and easily maintained automatic production line.

AN AUTOMATIC production line for making layshaft cluster gears was demonstrated in Birmingham, last week, by Charles Churchill and Company Limited. The line was manufactured by Churchill Gear Machines Limited for the Austin Motor Company. It is a development of a similar "Link Line," as it is called, made in 1958 (ENGNG., vol. 186, 1958, p. 646). The output of this latest line is greater than that of its predecessor and the automatic gauging equipment has been abandoned in favour of "snap" checks by inspectors. This is because odd pieces of swarf, which inevitably get into the gauging equipment, stop the whole production line unnecessarily.

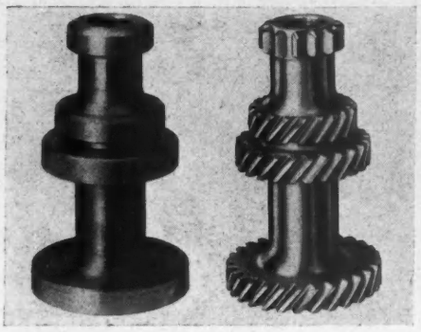
Although the line incorporates five different types of machine tool together with washing stations, the automatic handling throughout the 200 ft long gear line is achieved by the use of only two types of automatic machine loader and two types of between-machine conveyor mechanism. The grinding machine, which is the last machine on the line and is a separate unit, has a single loading arm using a similar method of operation but loading is by gravity.

The CGM transfer arm, which has been applied extensively to hobbing machines over the past four years, is also applied to gear shaping machines, and thereby satisfies the loading requirements for the two types of machine in which the gears are cut on a vertical axis—the eight Churchill Mark IV Rigidhobbers and the five Fellows high speed gear shapers. With the exception of a minor change in the mounting of the transfer arm required on the shaping machine, all loaders and control circuits are standard, thus facilitating service and maintenance, and reducing design and installation costs to a minimum.

The CGM hydraulically operated auto-loader used on the gear shaving machines in the line is of improved design and so arranged that, from the preload position, a trunnion type gripper places the component between two hydraulically operated work holding centres. On completion of the shaving cycle the centres withdraw and, at the same time, a lever supports the gear and deposits it on the gravity conveyor from which it rolls into a vertical elevator.

The auto-loader satisfies the loading requirements of gear rounders and chamferers. Nine auto-loaders are therefore used in the line, covering all the horizontal axis machines; that is, four gear shavers, three chamferers and two rounders, except that the latter are pneumatically operated instead of hydraulically.

The between-machine conveyors are again of two standard types, one for vertical and the other for horizontal axis carrying. The conveyors are all constructed from standard components and sections, again providing advantages in servicing and maintenance. Prior to gear cutting on the automatic line, the laygears are machined all over including the centre hole, each end of which is cone centred to provide the location for all subsequent operations.



A layshaft cluster gear before and after processing on the automatic production line.

A view of the Link Line showing the Fellows-England gear shapers on the left.

The automatic line commences with a bank of eight Model S 815 Mark IV Churchill Rigidhobbers arranged hydraulically and electrically for in-line loading. To reach the production required, three of the eight machines hob the fourth speed gear, three machines hob the third speed gear and the remaining two machines hob the first speed gear.

The laygears introduced to the conveyor move to the first of the three hobbers for fourth speed gear and build up a small storage bank of gears. Further components are deflected to by-pass the bank and feed the second and third machines—again forming small banks. The first component to reach the machine moves into a preload arm operating a microswitch which signals the start of the machine cycle, when the preload arm slides the component across the conveyor to the pick-up station where the transfer arm grips it and then lifts and transfers it to the cutting position. After a predetermined time delay, the preload arm returns to the centre of the conveyor allowing the next component to move into position ready for preloading when the machine has completed a full cycle.

After gear cutting, the transfer arm returns the laygear to the conveyor on the inner of three tracks into which the conveyor is divided, and along which it moves to bypass the next machine, but to be diverted back into the centre track for feeding the next three machines. The outer track is used by the components which bypass a storage bank to supply the next two machines. A pneumatically operated gate mechanism prevents them from moving along the inside track to pass a machine when it is being loaded.

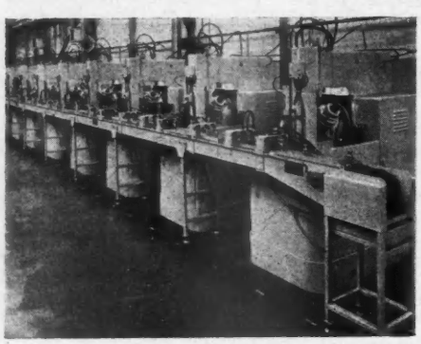
With this type of conveyor mechanism, the machines are individually operated, so that any one of the eight machines can be stopped for tool changing without affecting the remainder, and each machine will wait and automatically start when a component moves into the preload arm. The eight machines can therefore balance out their production times and can each be operated for sufficient length of time to enable tool changing to be carried out on the preceding machine.

Leaving the bank of hobbing machines, the laygears pass to the end of the conveyor where they turn over under gravity on to horizontal guides and roll to a Churchill gear-wash for cleaning. The gear-wash uses a hot chemical high pressure spray system and removes all cutting oil and swarf. The duration of the hot spray is short and insufficient to raise the temperature of the gear to affect gauging. An air jet system dries the gears before they leave to roll via a tip-over attachment on to the gear shaper conveyor.

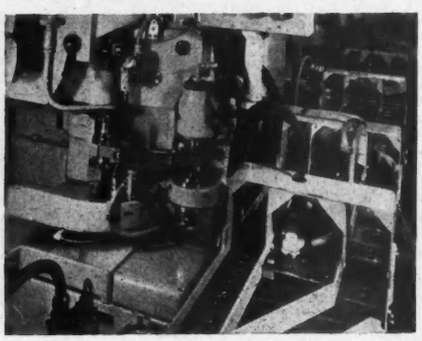
Five Fellows-England high speed gear shapers, type 7125A, are used. These were made by Alfred Herbert Limited of Coventry. They are fitted with CGM transfer arms, hydraulics being specially provided to operate the transfer arm and the machine tailstock.

After another wash, the laygears then pass to the Churchill gear chamferers and the Churchill gear tooth rounders. These machines are designed round the Churchill auto-loader, and can be used for varied machining operations by the use of different cutter heads and various forms of tooling.

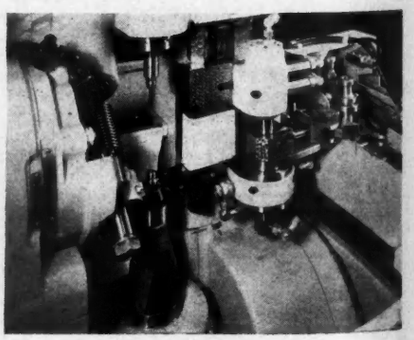
The laygears are clamped in the chamfering machines by head and tailstocks similar to those used on shaving machines. They are meshed in backlash with a rotary cutter, the head of which



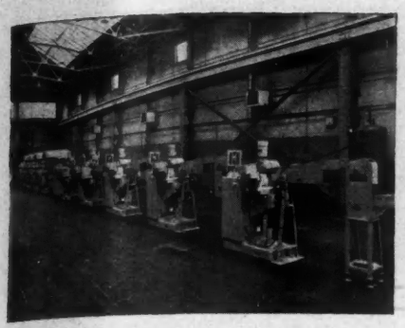
The start of the new production line showing the bank of eight Churchill Rigidhobbers.



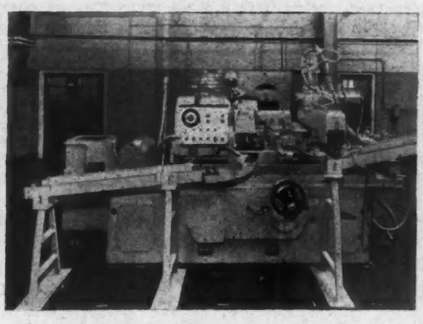
The standard free-flow conveyor system and CGM transfer arm fitted to one of the shapers.



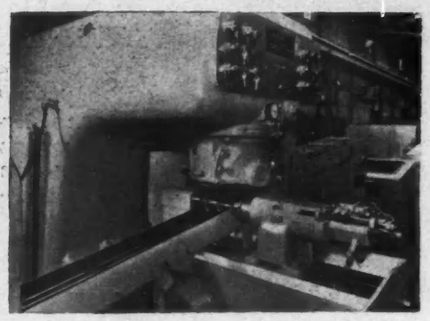
A close-up of the loading mechanism on one of the gear hobbers at the start of a cycle.



A view of the line showing the chamfering and rounding machines with the shavers on the left.



The Newall cylindrical grinder which rounds the outside diameters of the three helical gears.



A close-up of a Churchill Model FAU 8 in in-line gear shaver, with the guards removed.

moves quickly to the left and to the right in order to chamfer both sides of the teeth and remove the acute edges of the helical gear.

After chamfering, the component is released and lowered on to a discharge chute from where it is elevated and placed on the supply chute of the next machine. Microswitches fitted to the chute signal the appropriate machines to stop when the chute is either full or empty.

In the next section, of tooth rounders, components are held by pneumatically operated head and tailstocks which are turned by the geared headstock which, at the same time, oscillates the table in the correct sequence for tooth rounding. The pencil type cutter carried in a substantial quill can be rapidly retracted to allow components to be automatically loaded.

The laygears are then passed through a gear-wash and deburred by hand before they are loaded on to the supply chute of the next machine, a Churchill FAU in-line gear shaver. To provide straight line loading, the tables of the shaving machines have been turned through 90°, loading again being accomplished by a Churchill auto-loader.

The storage facilities on the shaving, rounding and chamfering machines are such that any of the machines can be tool changed without stopping the line, the storage banks being sufficient to feed the following machine for the period of time required to change the tool.

On leaving the shaving machines, the laygears pass through another gear-wash and roll to a bank supplying the grinding machine on which the outside diameters of the three helical gears are ground by a formed wheel fitted with automatic wheel truing compensation. This machine, supplied by the Newall Engineering Company of Peterborough, is a type LA 12 24 in cylindrical grinder. It is fitted with a Newall designed pneumatically operated loader, which is similar in operation to the CGM transfer arm, but applied to the horizontal axis rather than the vertical.

The laygear is gripped, lifted and then transferred by the arm to the grinding position. After grinding, it is released and rolls down a curved chute to a standard section of conveyor where the automatic gear line ends; the laygears are then ready for heat treatment.

The output of the line will be 64 pieces per hour. Vital statistics of the four gears (which will be used in the new Austin Seven) are as follows: 4th speed—28 teeth, 13·054 DP helical; 3rd speed—24 teeth, 13·054 DP helical; 2nd speed—19 teeth, 13·054 DP helical; 1st speed —13 teeth, 10 DP spur. Cycle times are respectively: 1 min 30 sec, 1 in 15 sec, 4 min 6 sec (the shaped gear), and 1 min exactly. The loading times for all four gears is 15 sec.

Classifying Sheet Metal

A new quality control system for the sheet metal and tinplate industries is being produced by the metal industries division of the English Electric Company. This sheet metal classifier is used for sorting sheared sections of cold strip and rejecting faulty pieces.

Faults such as pinholes, off-gauge and poor finish are detected during the inspection of the continuous strip. The sorting into grades can only be done, however, when the strip has been cut into individual sheets.

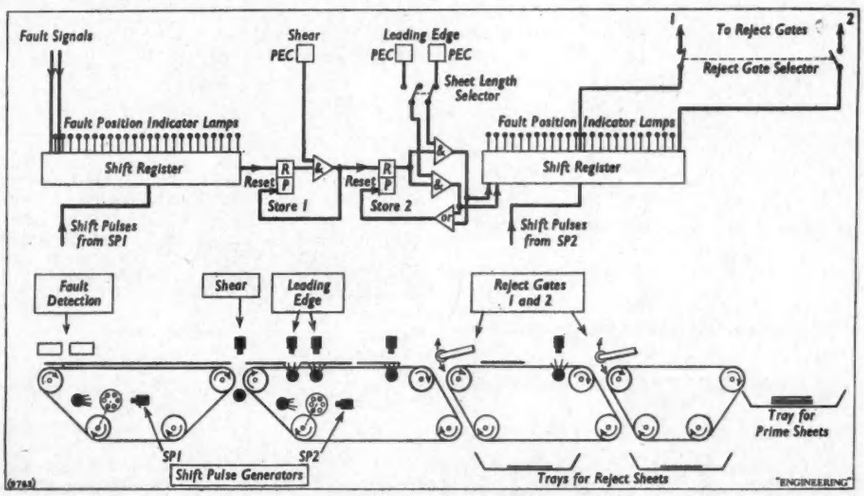
The sheet classifier stores the information on strip quality obtained at the time of inspection and uses it when the sheet is cut ready for sorting into piles. The information is stored and processed by Datapacs, standard transistorised logical elements.

From these standard elements, a sheet classifier system of any size and complexity can be built, for a line of any speed and with "cut length" ratio—length variation—of as much as 10 : 1. The first units will shortly be installed on the No. 5 cut-up line at the Abbey Works of the Steel Company of Wales Limited and on two cut-up lines at Richard Thomas and Baldwins Limited at Ebbw Vale. A further unit is to be installed in a South African steel works.

The Abbey Works unit will be on a steel line operating at 700 ft per min, with cut lengths ranging from 40 in to 180 in. Sorting will be into rejects and prime sheets.

On two tinplate lines at Ebbw Vale, both operating at 1,000 ft per min and with cut lengths ranging from 18 in to 42 in, sorting will be into four piles: sheets with pinholes, off-gauge material, other rejects and prime sheets.

The Datapac standard logical elements are in the form of standard plug-in packages. Each package contains a number of elements capable of performing a specific logical function. These elements can operate from the output of the preceding element so that a series of elements can be made up to form any desired logical system.



The operation of a typical sheet metal classifier.

Faults detected by the instruments are stored in the first shift register at a point corresponding to the instrument position. Shift pulses timed to the conveyor movement are applied to the register so that the fault signal moves within it in time with the movement of the faulty section of strip on the shearing line. The signal transfers from the register to "store 1" when the fault passes the shear position. This then indicates that the next sheet which is to be cut is to be rejected.

When a sheet is cut this is detected by a device which causes the signal to be transferred from "store 1" to "store 2." This indicates that the last sheet is a reject. The leading edge of this reject sheet is now detected by one of the leading edge photocells and transferred to a suitable position in the second register. The signal of the reject sheet is then shifted within the second register so that it appears at a reject gate just before the leading edge of the sheet reaches the gate. The signal is used to prime the gate control so that it rejects the faulty sheet when its leading edge reaches the gate photocell.

Two leading edge photocells are used after the shear to cover the range of sheet lengths used. One is used for short sheets and the other for long ones. Either is suitable for sheets of medium length. Selection of the photocell is automatically done by the shear cut length setting.

Normally, mechanical reject gates are used, but more complex methods such as overhead magnetic conveyors with variable drop-off points can be operated with the new system.

Large Press Dies for Car Body Panels

Body panels for the automobile industry call for large press dies. Vickers-Armstrongs, with their capacity for heavy precision work, have now established themselves in this field.

IN BRITAIN, there are many companies who can make small press tools but few with the capacity to produce large press dies.

With an expanding motor industry, there has been a corresponding demand for dies to produce car body components such as roofs, doors and other panels. Until quite recently this demand could only be met by additional dies from the Continent.

With the encouragement and assistance of part of the British automobile industry, Vickers-Armstrongs (Engineers) Limited, Elswick Works, Newcastle upon Tyne, set up a Die Manufacturing Department in 1956 at a cost of about £500,000 to supply large press dies suitable for automobile panels. It fitted in well with their plans for diversification, brought about to a certain extent by the running down of the armament programme. The die department has now completed over 1,400 dies and is well able to compete both in price and delivery with British and foreign subcontract die makers. Fig. 1 shows the component parts of a draw die for producing the rear-wing panels for the Sunbeam Alpine. Fig. 3 shows the upper and lower halves of the front-wing panels for the Humber Snipe.

A large section of the motor industry depend on Vickers to supply them with Clearing presses and Vickers have been assisted by a part of the industry who have provided them with the "know how" required for this specialised branch of engineering. The assistance took the form of training personnel for the design and production of dies as well as giving guidance in the layout of the shops.

The degree of liaison between the body stylist and the die designer should be very high. Fashion largely dictates the stylist's design, but a good stylist will not design a car body having panels which are difficult to produce. He should have a good idea as to how sheet metal will respond during pressing.

When a car body design has been conceived and more or less finalised, plans are drawn and a full scale wooden mock-up made. At this stage a tool designer is called in and marks "joint lines" or dividing lines on the body to show where he considers it will be best to make divisions for dividing up the pressings. Having decided on the joint lines the result is a car broken down into components or what are known as skin panels—the parts of the car body which can be seen.

Each section is then allocated to a tool planning engineer who decides which type of press to use and the number of operations required to form each pressing. Tool designers often find means of improving planning during the design stage.

Metal for body pressings is most often 21 BG (0·035 in) thick and is of cold-rolled extra-deep-drawing quality which does not require annealing between operations.

In certain respects the duties of a tool designer-draughtsman are very exacting indeed. All draughtsmen have to think in three dimensions, but in body panel work they have to think in three dimensional curves.

As with all other sections of engineering, the press shop is tending more and more towards automation. Many of the dies made by Vickers have built-in units to eject the pressing. Fig. 2

Fig. 1 (Above) Component parts of a draw die for producing rear-wing panels for the Sunbeam Alpine. Some sample pressings can also be seen.

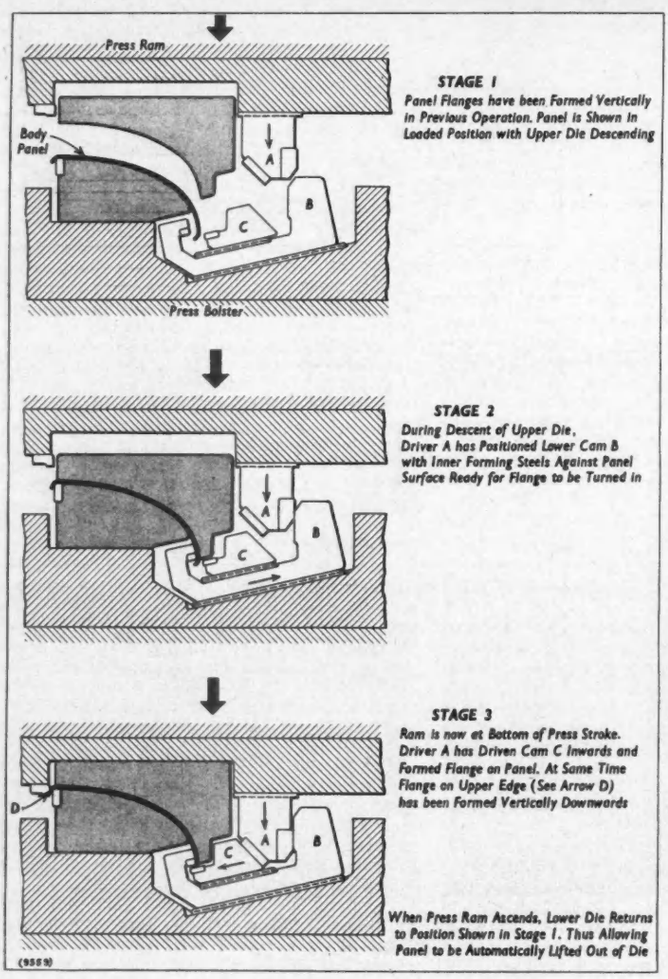
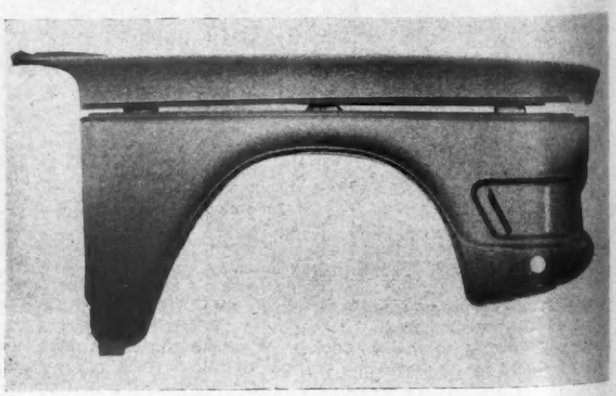

Press Ram
Body Panel
A
B
C
Press Bolster
STAGE 1
Panel Flanges have been Formed Vertically in Previous Operation. Panel is Shown in Loaded Position with Upper Die Descending
STAGE 2
During Descent of Upper Die, Driver A has Positioned Lower Cam B with Inner Forming Steels Against Panel Surface Ready for Flange to be Turned in
STAGE 3
Ram is now at Bottom of Press Stroke. Driver A has Driven Cam C Inwards and Formed Flange on Panel. At Same Time Flange on Upper Edge (See Arrow D) has been Formed Vertically Downwards
D
When Press Ram Ascends, Lower Die Returns to Position Shown in Stage 1. Thus Allowing Panel to be Automatically Lifted Out of Die
(9559)

Fig. 2 (Left) Method of flanging car body-panel having upper and lower flanges inclined towards each other.

Fig. 3 (Below) Upper and lower halves of the wing panels for the Humber Snipe for which Vickers have recently made dies.



shows the operation sequence for flanging over the edges for a motor body panel. It is, as can be seen, necessary to withdraw the parts which bear against the metal and form the flange before the component can be ejected. The ejecting mechanism is air operated.

When the dies have been designed, it becomes a production story. In order to show the follow through to the finished pressing, brief mention is made of the process.

Wooden models, or masters of the finished panel (see Fig. 4) accurate to within 0·005 in are generally supplied by the car manufacturer. These also serve as machinery aids in planning the operations for the Keller profile milling-machine. The models, made from laminated mahogany, serve as an accurate guide to the finished pressing and from them glass-fibre epoxy resin plastic moulds are made for supplying to the car manufacturer for checking fixtures and drill jigs. In addition, plastic moulds are made, to serve as masters for the "spotting down" or hand finishing of the top die. The bottom die is always spotted down using the finished top die.

Plaster moulds are made for the castings and for the pattern which the Keller follows. The castings themselves are in cast iron and often have steel inserts for the wearing surfaces. Vickers have a great advantage over many of their competitors in that they have their own foundries at Elswick.

Vickers have installed five British Clearing presses—which are also made at Elswick—in the die department. Two of these are spotting presses and are capable of handling dies up to 12 ft 6 in long. The other three are used as try out presses for giving final proof and acceptance trials to the dies. Their normal practice is to try out the dies to the customers satisfaction and supply as many as 500 sample panels so that the manufacturer has an initial set with which to commence a production run.

This article has dealt mainly with dies for the automobile industry, but Vickers can and do undertake other large die work as well.

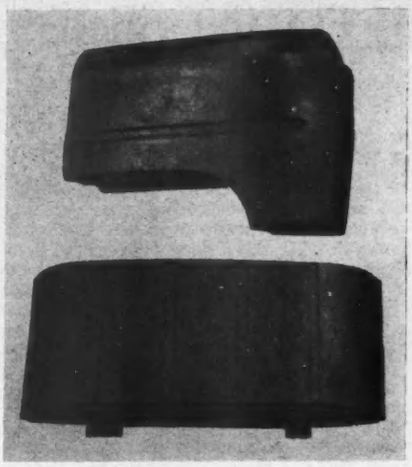


Fig. 4 Typical wooden models, accurate to within 0·005 in, as used in the manufacture of dies.

Pipeline Couplings Can Eliminate Expansion Joints

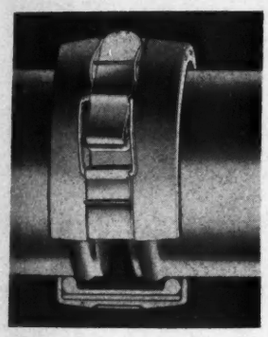
Flexible couplings which permit both axial and angular deflection of the pipes and a misalignment of up to $\frac{1}{16}$ in when fitting are now available. By using such couplings in a pipeline system expansion joints are claimed by the makers to be unnecessary. Tubes are beaded or flared at the ends to prevent pulling out through the seal under unrestrained conditions.

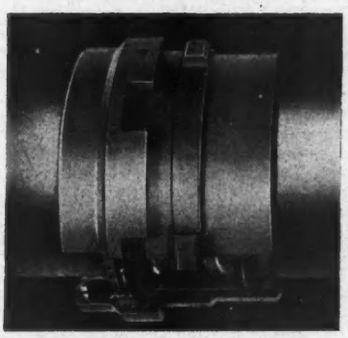
Three types of coupling are available from $\frac{1}{4}$ in to 9 in dia from Aero Controls Limited, Industrial Estate, Weedon Road, Northampton. They comprise a lightweight version with a twin beaded seal suitable for both aircraft and commercial systems, a screw type with O-ring seals, mainly for aeronautical applications, and an industrial design for heavy duty applications. This latter type also incorporates the twin bead seal.

The lightweight coupling comprises a split housing, a metal sleeve, a twin beaded rubber seal and a clip for securing the housing valves together. This clip can be a toggle quick-release type as illustrated (left) or any other form of clamping device such as a worm-drive clip. Sealing in this instance is by the fit of the sleeve on the rubber cylinder. Endwise restriction is effected by the flanged ends of the housing when they are clipped together.

The screwed type (right) comprises a main body with a retaining flange at one end, a nut, two split retaining rings, one split spacer and two O-rings. The object of splitting the retaining rings and spacer is to enable them to be passed over the increased diameter of the tube ends into their correct position. On assembly the action of screwing on the nut compresses the rubber rings between the retaining rings, forcing the rubber on to the tube, thus making a seal. Locking is by a circlip, one end of which engages slots in the nut and the other end the castellations on the body.

A heavy duty version is also available with the sealing portion of the same configuration as the lightweight type. The housing, however, is usually a hinged formation with toggle bolt and trunnion locking. Dust seals can be incorporated in the ends of the housing if dust exclusion is important.





These pipe couplings allow for both angular and axial deflection of the pipes and can make the use of expansion joints unnecessary. The lightweight version is shown on the left and the screwed type on the right. A heavy duty version is also available.

Progress Report on Britain's VTOL Aircraft

Progress reports on the development of Britain's two vertical take-off aircraft have recently been released.

The Hawker P-1127, which has previously only made tethered and free hovering flights and ground runs, has recently made its first conventional take-off. It made a forward flight and was airborne for about 22 minutes under normal flight conditions.

Using a single Bristol Siddeley BS 53 engine for both forward and vertical flight, the transistion is made possible by four movable jet nozzles which enable the whole thrust to be directed downwards for vertical take-off and then gradually turned backwards for forward flight. Braking in flight is possible by directing the thrust forwards.

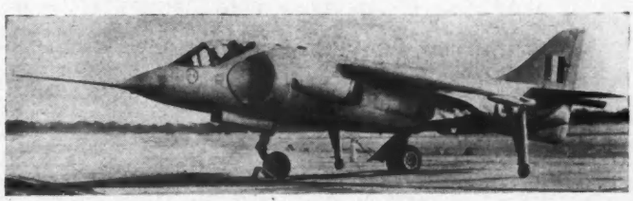
The test programme will now continue in the development of transistion from vertical hovering to forward flight.

The system of movable jet nozzles, say Bristol Siddeley, minimises ground running problems of recirculation, intake of debris, and ground erosion because with the exhaust discharging rearwards like a conventional turbo-jet, ground running is normal.

During recent tests at the RAE Bedford, the Short SC 1 has taken off vertically from a flat unprepared concrete surface. Hitherto a platform of the type used during the demonstrations at Farnborough last year has been considered necessary to channel away the hot exhaust gases of the aircraft's downward-facing lift engines. These gases, if recirculated and drawn into the air intakes, might cause a drop in power and consequent loss of performance. In some quarters it was also thought that direct take-offs might be the cause of severe ground erosion.

The tests at Bedford have shown that these difficulties can be overcome. Erosion of the concrete surface was slight, being limited to a small area, and there was no adverse effect on the aircraft's handling characteristics. The SC 1 remained completely stable and took off quite easily, despite ground suction produced by the splaying out of the exhaust gases.

The main problem no remaining is to provide a means of ground running the vertical engines for test without using a platform. A simple ground scoop is being developed.



The Hawker P 1127 vertical take-off strike reconnaissance aircraft has recently made its first conventional take-off and flight forward.

On the Shelf

By Frank H. Smith

IT MUST have been great fun to have lived in the days when spring meant young ladies dashing around in wisps of nylon hotly pursued by gents with cloven hooves beating a solid note on an alto sax, but all that is left to us is the picture of men in lounge suits being chased out of their dens and studies by perspiring housewives in mobcaps and wrapover overalls. This is the time when, under duress, drawers and untidy heaps on the floor have to be cleared. Now, it is just possible that in that junk there is a photograph of an old bridge, an old locomotive, an old piece of machinery, an old aeroplane. There may be a pamphlet for which you have written away and for which you have no further use. For Pete's sake do not listen to the wife's command to burn it until you have convinced yourself that none of the society or institution libraries can have no use for it. Don't say "Who the hell wants this," but rather "I wonder where I could send this?" Then, if it is still not wanted, the librarian is better qualified to chuck it away. *Your* conscience will be clear anyway.

Collins (9-12 Bow Street, London, WC2) have issued, in a different format from the usual for such things, a complete book catalogue for spring 1961. The front cover is a photograph of that most famous of lionesses, Elsa (alas, no longer living) and her two cubs facing each other across an expanse of water. There are many titles in the catalogue to help form a basic reference library, and a full list of the Collins Leather Classics (97 titles) bound in leather at 12*s* 6*d* each.

If any of you wish to polish up your French, Heinemann (Windmill Press, Kingswood, Tadworth, Surrey) will send you a leaflet devoted to the sort of French book with which you can polish it up. "François sur la Côte d'Azur" looks just the job and I am sure that my cousin français François vous aidera beaucoup de comprendre la langue.

The Cambridge University Press spring list contains the titles of those Cambridge Paperbacks that have already been published and also their contemplateds.

I wonder if there is any future in a library devoted entirely to encyclopaedias and nothing else? There is plenty of scope. Reinhold weigh in with three fresh ones to kick off 1961. They are, respectively of Spectroscopy, Microscopy and the Biological Sciences. Capital outlay would be a bit of a difficulty in the case of the Chamberses and the Britannicas, but these are a mere $25 for the first two and $20 for the third.

In view of the recent interest in the formation of the Universe you may like to hear of Volume 260 (No. 1301) of the Royal Society *Proc.* A (Burlington House, London, W1) which contains a discussion on problems of stellar evolution under the leadership of F. Hoyle.

Cygnet Film Productions, Bushey Studios, Melbourne Road, Bushey, are trying to persuade me to make a film. I've got to pay for it of course. 22 minutes would cost between 1,500 and 3,500 smackers, and half that time between 900 and 2,100. That's in colour, and black and white is less of course. They make it sound quite simple and trouble-less, so if you've something to flog—try Cygnet.

Now and again the British Standards Institution captures the public imagination with a standard and the newspapers report its production and everybody realises what a damned good thing the BSI is. Such a standard was the one on paraffin heaters. More recently, I see, some papers gave a par. to the soft-hearted B.S. 3149, Part 2, dealing with the humane transportation of firefinches, lovebirds, canaries and budgerigars. It *is* nice to think that the efficient BSI can spare time for such things.

Strength through Plasticisers

Symposium on Effect of Water-Reducing Admixtures and Set-Retarding Admixtures on Properties of Concrete. ASTM Special Technical Publication No. 266. *American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.* ($7·50, members $6)

The proceedings of a symposium sponsored by the American Society for Testing Materials on the effect of water-reducing and set-retarding admixtures on the properties of concrete have now been published in book form. They provide the most comprehensive information yet available on these admixtures, which are often referred to as plasticisers in this country. Papers were presented on many problems associated with the admixtures including their chemical action in concrete, their production and their use under practical conditions.

Two classes of admixture were considered in the papers; firstly lignosulphonic acids and their salts, and secondly, hydroxylated carboxylic acids and their salts; either class of these materials may be modified or a derivative made as an admixture. Most water reducing chemicals are also set-retarders and the retarding effects may be modified by the addition of an accelerator without losing their water-reducing effect so that the resulting product may accelerate, retard or have little effect on the rate of hardening of the concrete depending upon the exact composition. The first class of admixtures usually entrain 2 to 3 per cent of air whereas those in the second class do not entrain air. Either class of material can be made to entrain or not to entrain air according to modifications made to the basic material.

The amount of water reduction varies, being generally between 5 and 15 per cent, though a part of the reduction was probably attributable to the entrainment of air. Agents have been found to be effective in both Portland and high-alumina cements, though in Portland cement the effect was greater in those cements where the proportion of tricalcium aluminate or alkali content was low. The retardation of setting time also varied considerably depending upon the quantity of agent, the temperature and the constituents of the mix. Bleeding of concrete is also reduced when the agents are used; this effect is probably due to the entrained air and the reduction in water content.

The most important effect of the agents on the properties is that on the compressive strength. In general the 28 day compressive strength of the concrete was increased to a greater extent than would be expected simply from the amount of water reduction produced. Figures quoted include an increase of 15 to 18 per cent in compressive strength above a non-air-entrained concrete with 10 to 15 per cent water reduction, though it is apparent that under some conditions the increase would be much less.

The rate of gain of strength of a concrete containing a set-retarding agent is different from that of a concrete without the agent. Assuming the correct quantity of agent is used, the retarder should be effective only for a limited period after which the concrete should gain strength rapidly to reach normal or higher values at 1 day. Hermetically-sealed test specimens show that the advantage in strength is still present after 5 years.

A considerable reduction in the permeability of concrete containing a water reducing agent was reported. Some investigators reported a reduction in drying shrinkage and moisture movement, and increased resistance to freezing and thawing and to sulphate attack but the changes are small.

Agents have been applied to most forms of concrete construction with reported success and although reduction of the water content in concrete is the property usually required, the retardation of setting may be of greater practical importance particularly in ready-mixed concrete and in concreting in hot weather. Applications specifically treated in the symposium were structural and mass concrete, mass concrete containing pozzolana and ready-mixed concrete. The testing of the admixtures is considered in one paper and the detection of lignosulphonate retarders in cement suspensions and pastes in another.

The most usual application of water-reducing agents appears to be to increase the workability, to obtain a higher strength, or to reduce the cement content in an otherwise similar concrete. The value of such improvements in the performance of concrete can of course only be measured in terms of the cost of construction, and this then was not considered in any detail in the symposium. However, the estimated annual use in the United States of concrete containing water reducing agents is 25 million cu. yd, from which there would appear to be many instances where the use of the agents is economic.

The economic value of these agents remains to be proven under conditions in the United Kingdom where the best admixture to concrete may well still be a little more cement. Nevertheless this book undoubtedly deserves detailed study by concrete technologists.

B. W. SHACKLOCK

How to Choose a Car

The Autocar Road Tests: Autumn 1960 Selection. *Iliffe.* (6*s* 6*d*)

With arrival of spring, and a slight easing in hire purchase restrictions, the thoughts of many motorists will turn towards that much discussed question—"which car shall I buy?" The British motor industry offers its customers an extremely wide range of products. This diversity enables most people to buy a car which is well suited to their particular requirements (provided that they can afford it), but at the same time, because of the wide range, the actual choice within a given price bracket may be difficult—particularly as the majority of owners do not have the opportunity actually to drive a large number of cars. The difficulty in choosing for oneself makes the road test reports of our leading motoring magazines among their most popular regular features, and has undoubtedly influenced the decision, taken several years ago, to produce a series of road tests in book form.

The Autocar Road Tests—Autumn 1960, which is the subject of this review, contains full tests of some 19 vehicles, and in addition to a collection of British cars there are also samples from France, Germany, Holland, Italy, Russia and the United States. In certain cases the alternative performance figures obtained with various optional features such as a different type of transmission or a modified engine are also included.

Performing a road test is not nearly such a glamorous occupation as the uninitiated might suppose. True, there is always a thrill when you are first trying out an exciting new model, possibly in a foreign land, but there is much more to it than that. One can perhaps divide the test into two parts: the hard facts, as indicated by the readings obtained from the instruments; and the rather less tangible things which become apparent as the tester carries out his task.

It is very necessary that the combination of these two aspects of the test should be brought out in every report. Road tests must record not only the car's performance in terms of time and distance, but must also indicate whether the

vehicle is good of its kind, and how it fits into the general scheme of things. Thus for each test two sets of standards must be applied: a purely scientific standard for measuring the various performance figures; and what might be called informed opinion for tackling the less tangible part.

In deciding whether a car is good of its kind, one must consider relative rather than absolute standards. For example, a standard of interior finish or degree of smoothness acceptable on a car costing only a few hundred pounds might well give grounds for adverse comment on a vehicle costing several thousands. In a similar way, handling characteristics on a super sports car must be assessed somewhat differently from those of a relatively slow and roomy family saloon. In the written part of the tests, then, it is necessary to consider the type of individual who would be likely to purchase the car in question, and then in addition to commenting on absolute values, to indicate how the vehicle would meet the requirements of the kind of person for whom it was intended.

The Autocar road test book gives a well-balanced picture of the way the car performs, and the tester's general impressions of its handling and road manners, so that a would-be owner is given a useful guide which may be of considerable assistance. There is, however, one point about which little information is provided—routine maintenance and lubrication. It is true that mention is usually made of the number of greasing points, but the thing that really matters is how seldom one needs to look at them, and a little more information on this extremely important subject would undoubtedly be welcome.

Priced at 6*s* 6*d*, *The Autocar Road Tests* is extremely good value for money. It is well illustrated and contains much useful data, and in addition to justifying a space on the bookshelf of anyone connected with the motor industry, or who is thinking of buying a new car, it can also be recommended as providing very interesting reading.

JOHN RABSON

Semiconductors: Hard But Brittle

Mechanical Properties of Intermetallic Compounds: Symposium held at 115th Meeting of the Electrochemical Society, Philadelphia, May, 1959. Edited by J. H. WESTBROOK. *Wiley, New York and London.* (76*s*)

In recent years intermetallic compounds have become a subject of widespread interest, as is evident from the papers collected in this volume. They were presented at a symposium held in Philadelphia in 1959 under the auspices of the Electrochemical Society, and were submitted by countries which included not only the United States but also the Soviet Union, the United Kingdom, Germany and Japan—a notable measure of international support.

Interest has been stimulated partly by the semiconducting properties of these compounds and partly by their hardness at high temperatures, which make them promising materials for a number of industrial and military applications. The topics covered by the papers are as follows: review of the literature (1 paper); the effects of crystal structure and environment (2 papers); experimental techniques for studying mechanical properties (3 papers); role of dislocations and point defects (4 papers); and mechanical properties of specific compounds (7 papers).

The great disadvantage of intermetallic compounds is their brittleness, and the papers include descriptions of numerous attempts to improve the ductility. Inevitably many of these attempts have proved unsuccessful, but some fairly successful methods are described and they offer exciting possibilities for future developments. One such method employed in the USSR (E. M. Savitskii) depends on the creation of a ductile envelope of a soft metal round the crystals of the intermetallic compound. This method is used for refractory compounds with compositions bordering on low melting-point eutectics. A compound based on such a composition has a large range of crystallisation, that is, a state in which the compound has crystallised out but the eutectic is still in liquid form. The principle of the method is to pump off the liquid and to introduce another liquid metal to replace the eutectic between the dendrites of the compound. By suitable control of the conditions, structures have been produced with considerably improved mechanical properties.

A considerable amount of research is being carried out on the high-temperature properties. From a production point of view the observation that practically all intermetallics soften at temperatures in the range 0·7 to 0·9 melting point is particularly important, in that it suggests the possibility that complex shapes may be produced by conventional hot forming. Some successful attempts to extrude intermetallic compounds are described by D. L. Wood.

A particularly interesting feature of this book is the wide variety of theories put forward to explain the observed mechanical properties. Explanations invoking Brillouin zones, dislocations, structural effects such as the degree of ordering, Pauling's theory of valence bonds and many other concepts are put forward by the various authors, and the impression is given, very properly, that much remains to be done before a reasonably complete picture will emerge.

As is inevitable in a collection of symposium papers there is a certain lack of uniformity of style. The papers individually, however, are so good that one is prepared to overlook this fault.

The book is well printed and stylishly set out. It is profusely illustrated and contains some 200 references including a number to work published as late as 1959. The editor should perhaps have cut out some of the introductory material given with the later papers, which merely repeats information contained in the review of the literature. It might also have been kinder both to the reader and to the contributors if the verbal discussion had been tidied up.

These are minor criticisms, however, and should not be allowed to detract from the book, which is a very useful addition to the literature.

R. B. HILL

Save Our Shipyards

The Economics of Shipbuilding in the United Kingdom. By J. R. PARKINSON. *Cambridge University Press.* (40*s*)

At a time when this country's export drive is once more giving cause for concern, the problems of the shipbuilding industry have a particularly topical flavour. It is generally agreed that since the Second World War this industry has not played as large a part in the country's export performance as certain other engineering industries, and it has become a point of controversy as to how far this failure has been due to the industry's own shortcomings and how far it has been a victim of national economic policy.

Shipbuilding has indeed been a controversial industry for the last 40 years. Its inability to build anywhere near the same proportion of the world's seagoing tonnage as before 1914 has been quickly equated to technical conservatism, slow-moving management and heavy unemployment in particular localities. In consequence shipbuilding has been, perhaps unfairly, placed at the very centre of this country's economic problems for several decades and it has been judged, and often found wanting, on emotional and political as well as logical grounds. Laymen who would pause with circumspection at the brink of an easy generalisation about the future of the thermionic valve reckon that they know all about ships.

Mr. Parkinson has asked most of the right questions in his book and he has produced answers with restraint. One feels indeed that his private opinions may well be more critical of the industry than is his book. He has clearly been painstaking and fair. In the end, however, the weight of his evidence comes down against the quality of management in parts of the industry and he is therefore at least on the side of fashion.

Is there a prescription for success in the industry after this painstaking analysis? Mr. Parkinson's better judgment tells him that it would be dangerous to be optimistic. He does not think that there is ground for feeling confident that the industry can escape from its past.

The picture is by no means all black. He finds the industry technically up to date especially in the medium sized yards. The labour force is skilled, although productivity compares unfavourably with foreign competitors. In the forties and fifties shipbuilding was starved of steel in the interests of the motor vehicle industry; steel capacity was thus built up to produce thin sheet at the expense of heavy plate. The author shows that this division was a much worse stroke of economic policy than rationing steel by the price system. He thinks that the industry can much better stand dear steel than lack of it. Shipowners are usually more sensitive to slow delivery than to higher prices. For the future, surely, the Government have learned this lesson.

In the past the industry has tried to overcome its problems of cyclical demand for new ships, at times almost unconsciously, by allying itself with its steel suppliers. This policy failed, for it was conceived as much to secure outlets for steel as to ensure sources of plate for shipbuilders.

Shipbuilders have also tried to develop yards for producing specialised tonnage, but here too they have failed. Mr. Parkinson believes that more could have been done along these lines before the War, and that a future breakthrough might be effected by specialisation in this way. But it would be necessary to forget any obsession with large passenger ships, built sporadically for reasons of prestige, and to concentrate rather on building and repairing such special tonnage as tankers; tramps and batch-produced cargo liners.

He is impressed, as others have been, by the success of some foreign yards in this respect. They have risked large-scale investment in new equipment and concentrated on simple designs of standard type wherever possible. This policy has paid off handsomely for the Japanese, for example, in the last five years or so. In the case of the Swedes (who are usually quoted as the successful neo-classical example of high investment, high productivity and high wages) the risk has been taken of carrying a high overhead in the shape of a large and well paid managerial, technical and supervisory staff. Calculated risks of this sort may have to be taken in future by

the shipbuilding industry in the United Kingdom.

On the demarcation problem, Mr. Parkinson is as frustrated on paper as the shipyards are in practice. The closer he looks at it the more difficult does it seem to prescribe any simple remedy. After a thorough analysis of the present complex wages structure (which at first sight appears deceptively simple); the problem of differentials between skilled, semi-skilled and fully skilled men; the strategically strong position of the welders and the politically strong position of the boilermakers, he favours a return to a straight time basis for payment. Bonus incentive schemes are common enough in Continental yards but do not raise productivity significantly.

He sees the way out as a matter of getting away from differentials and towards higher earnings and higher productivity all round. The difficulty is how to do so in practice. It looks as though the whole problem will have to await a new generation of managers and union officials with more flexibility and fewer haunting fears of the depression years. But can the industry afford the luxury of time?

One consequence of a greater specialisation in shipbuilding would almost certainly have to be a change in the structure of the marine engineering industry. The close affiliation of the two industries owes something to historic accident, notably the way the marine engineering industry developed alongside the shipbuilders on the Clyde. Today the largest engine concerns are in shipbuilding groups. The general system of licensing the production of types of marine engines has helped to perpetuate a heterogeneous pattern in the industry's structure.

Mr. Parkinson wonders, however, whether the stimulus this cooperation may have given to research among licensees and licence owners alike may not have been offset by a lack of coordination in development programmes. He sees salvation for the marine engineers in greater specialisation of production in fewer establishments.

In the author's view the trend is towards larger ships with bigger and more powerful engines—and hence fewer ships—unless his forecast of the rate of expansion of world trade is very wide of the mark. His opinions are not basically altered by the possibilities of technical developments in marine diesel engines, gas turbines or atomic energy.

Reasonable prosperity for the shipbuilding industry involves securing some 1¼ million to 1½ million tons a year of new orders from United Kingdom shipowners and half a million tons of dry cargo and tanker orders from abroad. Greater stability could come from a higher proportion of repair work, requiring heavy investment in repair facilities for very big ships. The figures themselves are not very daunting for a forward-looking industry.

In the past neither juggling with control of companies nor subsidies has helped much. Depression was the great and bitter rationaliser. Today neither nationalisation nor takeover bids can promote specialisation while retaining flexibility of outlook. Mr. Parkinson, like many others, sees the only hope in finding good managers and engineers and paying them well.

This is a thorough and intelligently provocative analysis with down-to-earth and therefore modest conclusions and prescriptions.

G. E. TEWSON

Rays Inadequately Exploited

Radioisotopes: A New Tool for Industry. By SIDNEY JEFFERSON. 2nd edition. *George Newnes.* (21*s*)

It is fashionable today to accuse British industry of conservatism and reluctance to introduce new methods and techniques. This criticism is to be welcomed, for the accusation has considerable justification; there is, with some bright exceptions, a tendency to stick to the methods which maintained Britain's industrial leadership fifty years ago, and if this weakness is pointed out sufficiently frequently maybe the industrialists will come to believe it before it is too late. A case in point is the use of radioactive materials in industry—the subject of this book.

In America the new tool has been taken up by industry much more enthusiastically than in this country, as evidenced by the surveys made respectively by the United States Atomic Energy Commission and the United Kingdom Atomic Energy Authority. Even after the application of correction factors usually considered necessary in such comparisons, it is evident that there is very considerable scope for effective savings by the industrial uses of radioactive materials in Britain.

An additional handicap facing these techniques is undoubtedly their association in the public mind with atomic bombs, fall out and associated health hazards. What is required is propaganda which soberly presents the commercial benefits to be gained and the feasibility of the methods without the need for elaborate and expensive precautions, while, at the same time, discouraging "gimmick" applications which serve very little useful purpose. Parenthetically, it was a surprise recently to read a very similar plea for Canadian industry—Britain is not always the only laggard!

Mr. Jefferson's book, addressed primarily to the business man, sets out to provide such propaganda. It is based largely on the work of the author and his colleagues in the Isotope Research Division of the UKAEA. Most of the industrial applications are mentioned and there is sufficient description of the fundamentals of radioactivity and of health and safety considerations for the purpose.

Unfortunately it cannot be regarded as wholly successful. It does not distinguish between the trivial applications and the important ones from the business man's point of view, namely, the money-savers; and the question of the relative costs of doing a job using radioactive materials or otherwise is hardly touched upon. One would like to see quoted many concrete examples of the economic benefits of the improvements in plant operation permitting greater through-put, the reduction in waste by closer control as, for instance, with thickness gauges, or the "trouble-shooting" job, detecting the malfunctioning of a still, for example, which may be corrected without the otherwise necessary complete shut-down.

Instead, too much space is given to descriptions of investigations which are not of general interest to industry, for example, the distribution of sewage in the sea, and the movement of sand in coastal waters. Similarly the direct production of electricity from radiation, and thermonuclear reactions cannot, as yet, be said to be tools for industry.

The book reads rather disjointedly especially near the beginning because of a fault in the order of presentation. The section describing the fundamentals of radioactivity and methods of measurement is left to the end, but some of the material is necessary for an understanding of applications described in the early part of the book. This leads to continual hopping between descriptions of applications and definitions of terms, descriptions of health hazards, statistical variations, properties of radiations and so on. Even so, some unfamiliar terms (for example, "*bremsstrahlung*") are introduced long before they are defined. The necessary fundamental information should come first.

There are a few errors in the later part of the book which should be noted if it were a scientific textbook but are perhaps unimportant in the present context. Nevertheless it is worth pointing out that knowledge of the relation between mass and energy was not necessary before nuclear energy could be released—it only gives information on the amount to be expected. It is true to say that chemically released energy, such as that from burning coal, is exploiting the relation between mass and energy—but no one knew until recently.

The book undoubtedly will give the layman an insight into the uses to which radioactive materials have been put, but will not, I fear, fire the industrialist with enthusiasm to exploit the methods.

A. F. HENSON

New Books

An Introductory Treatise on Dynamical Astronomy. By H. C. PLUMMER. *Dover Publications, New York; Constable, London.* (19*s*)

A facsimile reprint of the classic work by the one-time professor of astronomy in the University of Dublin and Royal Astronomer of Ireland, later Professor of Mathematics at Woolwich.

Advice to a Lecturer. By MICHAEL FARADAY. *The Royal Institution, 21 Albemarle Street, London, W1.* (2*s* 6*d*)

An anthology of Faraday's writings on the art of lecturing culled from his letters and laboratory notebooks.

The Great Organizers. By ERNEST DALE. *McGraw-Hill, New York and London.* (46*s*)

Here is new insight into high-level management, brought out by studies of the organisational problems of Du Pont, General Motors, Westinghouse and National Steel and the methods used by the "great organisers," Henry du Pont, Alfred Sloan, A. W. Robertson and Ernest Weir, respectively.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Plant

Induction Furnaces. GENERAL ELECTRIC CO. LTD., Erith, Kent. Mains and medium frequency induction furnaces for billet heating, both ferrous and non-ferrous. 4 pp. ill.

Tube Furnaces. MORGAN CRUCIBLE CO. LTD., Battersea Church Road, London, SW11. Crusilite tube furnaces for self construction. Temperatures up to 1,575° C. Leaflet in three languages. Ill.

Gas Mixtures. INCANDESCENT HEAT CO. LTD., Cornwall Road, Smethwick, Birmingham. Nitrogen-hydrogen mixtures from blast furnace gas to replace coke oven gas. Process described with diagrams. 4 pp. ill.

Gas Burners. PRIOR STOKERS LTD., 1-3 Brandon Road, York Way, London, N7. Automatic forced draught packaged gas burner units for outputs from 100,000 to 4,000,000 Btu per hour. 2 pp. ill.

The Reviewers

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Dr. R. B. Hill is a metallurgist in the Research and Development Department of the Central Electricity Generating Board. He is an M.Sc. and a Ph.D. in metallurgy.

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Marketing

Price Cuts by Rootes and Standard Triumph

GENEVA'S International Motor Show was chosen by the ROOTES GROUP for the announcement of substantial price cuts in the Hillman range selling in Switzerland. The reductions have been made in anticipation of the lower customs tariffs on British car imports which will take effect on 31 July under the European Free Trade Association agreement.

The price cut in the Hillman Minx de luxe saloon, the most popular of the range, is equal to £45, bringing the retail price to 7,995 Swiss francs (£660). The new Rootes financial plan in Switzerland now provides the lowest interest rates available in the country.

On the home market, STANDARD TRIUMPH INTERNATIONAL, only six weeks after opening their £2,500,000 assembly hall, have announced a £15 cut in the price of the Triumph Herald S model. This now costs £648.

Greater Investment in 1960 Fourth Quarter

Manufacturing industry's capital spending was 20 per cent higher in the fourth quarter of last year than in 1959, according to the estimates of the current Board of Trade *Journal*. The amount invested was approximately £291 million—most of the increase being due to expansion in iron and steel and the textile and motor vehicle industries.

There was a 21 per cent increase in building work and a 17 per cent advance in spending on plant and machinery.

Export and Home Orders for New Cranes

BUTTERS BROTHERS, the Glasgow crane making company, have obtained export orders for their newly designed cranes from Canada and Poland worth £300,000.

The Canadian order, worth £200,000, is for a 75 ton shipyard crane and a 75 ton electric overhead travelling crane. Among a series of orders for the company's shipyard level luffing tower crane is one from Poland worth about £100,000.

From British shipyards in the last few weeks have come orders for the new crane to a value of about £500,000. The floating dock recently ordered from the FURNESS SHIPBUILDING Company is to incorporate two 7½ ton Butters level-luffing shipyard cranes.

UK Rail Firms in South African Show

South African railway operators and the general public are being shown a cross section of British made equipment in the rail transport exhibit of the United Kingdom pavilion at the Rand Show in Johannesburg (12 March to 3 April).

Members of the LOCOMOTIVE AND ALLIED MANUFACTURERS' ASSOCIATION OF GREAT BRITAIN have sent rail traction equipment and models of locomotives, the Central Office of Information designed the exhibit and the BRITISH TRANSPORT COMMISSION have also sent models.

The ENGLISH ELECTRIC Company are showing working camshaft control equipment for a British Railways Southern Region multiple unit train. Their two working models are of the Deltic diesel-electric locomotive for BR and a wall mounted working section model of the Deltic diesel engine.

ROLLS-ROYCE have provided an eight-cylinder horizontal railcar diesel.

ASSOCIATED ELECTRICAL INDUSTRIES models include an electric locomotive for the SOUTH AFRICAN RAILWAYS. They are also showing, for the same railway system, a 570 hp traction motor, shown with the armature withdrawn.

The GENERAL ELECTRIC Company are showing mercury arc rectifiers and locomotive models.

The other manufacturers exhibiting on the stand are:

NORTH BRITISH LOCOMOTIVE
BRUSH ELECTRICAL ENGINEERING
RUSTON AND HORNSBY
HUNSLET ENGINE
WESTINGHOUSE BRAKE AND SIGNAL
SGE SIGNALS
AEI-GRS.

The British Transport Commission are showing models of a 25 kV ac electric locomotive and the 2,000 hp diesel-hydraulic (Swindon type) locomotive.

Loan to Pakistan for Railway Wagons

The total of United Kingdom loans to Pakistan has been brought up to £28 million by the new advance of £3 million which will be used to buy the railway wagons without which the country's transport system cannot grow.

On behalf of the Export Credits Guarantee Department the loan agreement was signed in Karachi by the United Kingdom High Commissioner. The Government of Pakistan was represented by the Minister of Finance.

In the past two years Britain has lent £18 million to Pakistan to assist in the completion of the first Five Year Plan and to start the buying from the United Kingdom of capital goods needed in the carrying out of the second plan.

Prospects in the Swiss Motor Market

The rising sales in Switzerland of a number of British motor manufacturers during 1960, and their confidence in the prospects this year, suggest that there is a chance that in this sharply competitive market the United Kingdom's export results will pull up from behind the German, the French and the Italian cars.

Among British companies, STANDARD TRIUMPH INTERNATIONAL more than doubled their Swiss sales last year, principally because they found a winner in the Triumph Herald. ROOTES were 40 per cent ahead in their sales and believe that substantial advances will again be made this year. With their Anglia selling briskly in the Swiss towns, the FORD company sales were up by almost 50 per cent. JAGUAR put on 35 per cent in the course of the year. The Swiss army has ordered £160,000 worth of Land Rovers.

The number of new vehicles registered in Switzerland last year was 90,000, of which 7,674 came from Britain. More than twice as many cars entered the country from the VOLKSWAGEN concern alone—16,422. OPEL were second in the list with 12,750 and RENAULT, selling 7,879, were just above the combined total from UK manufacturers.

Hawker Engines at Moscow Fair

HAWKER SIDDELEY INDUSTRIES Limited, a member company of the Hawker Siddeley group, are to show by engines, models and photographs, a selection of the company's fourteen basic engine types, ranging in power from 1½ to 4,440 bhp, at the Moscow British Trade Fair.

The three HSI engine companies, MIRRLEES, NATIONAL and PETTERS, now produce 145 different power units, including air cooled, water cooled, naturally aspirated, turbo-charged and turbo-charged with after-cooling models.

A self-contained diesel alternator set, made up of an 864 bhp National R4AUU eight cylinder turbocharged and after cooled diesel engine driving a 610 kW Brush alternator, with control and switchgear panels, will be the largest HSI exhibit.

Petter air cooled diesel units represent the other end of the power scale. Four of these will be the single cylinder PAZI, giving 1½ to 3 bhp, the twin cylinder AS2 (14 to 22 bhp), the twin cylnider PH2 (8 to 16 bhp) and the largest, the PDV8 (72 to 108 bhp).

Two Petter diesel-generators will also be exhibited and the rest of this part of the HSI stand will be concerned with the Hawker Siddeley Brush Turbine range of turbochargers. The display will include a sectioned and motorised example of a series 20 unit, as fitted to the Brush main line diesel-electric locomotives supplied to the British Railways.

Radar Reaches the River Medway

The Conservators of the River Medway, in Kent, have decided to use radar for the better control and guidance of the increasing commercial traffic now using the river.

Large numbers of oil tankers are now using the berths of the Kent oil refinery on the Isle of Grain and there are more dry cargo vessels coming into the Medway. The annual tonnage handled on the Medway has now risen to the fifth highest for ports in the United Kingdom other than the ports of the BRITISH TRANSPORT COMMISSION.

An interim scheme has been put into use, a Port Operations and Information Service at Sheerness, whose headquarters are in the Garrison Point Fort. This station has PYE VHF radio/transmitter equipment. Its patrol launch carries DECCA D404 marine radar and VHF r/t.

The complete new system, to be integrated with the Medway Port Operations and Information Service, will employ a Decca type 32 harbour radar with three Decca 16 in displays. VHF r/t equipment is to be provided by PYE TELECOMMUNICATIONS Limited. When it is completed the station will give detailed surveillance of all ships and craft in the area, making it possible to advise r/t equipped vessels of collision-probable situations and to regulate movement in order to save time and avoid accidents. A new Port Operations building will be built on Garrison Fort.

It will be possible with the three displays to cover an area from the Medway Buoy up to Canvey Point. The system to be installed will be similar to that supplied by the Pye company to the PORT OF LONDON AUTHORITY in 1959. Hague Convention (1957) international communication channels are to be employed.

Airline Results Bring Repeat Comet Orders

The Greek National airline, OLYMPIC AIRWAYS, improved its passenger carrying figures by 16 per cent last year over 1959, raised its mail load by 17 per cent, and increased the volume of cargo, baggage and excess baggage by the notable amount of 260 per cent.

This was in the year that Olympic Airways put their first de HAVILLAND Comet 4B into service. In their announcement giving the figures for the year's results Olympic say they have no doubt that introducing the Comet 4B contributed to the rise in the traffic although the Comets were not in operation until May and other airlines were putting up increasing competition with jets between Athens and North-West Europe during the year.

Olympic make particular reference to the absence of teething troubles in bringing the Comets into service, and to their high utilisation figures and low maintenance requirement in man-hours.

The result has been a repeat order from Olympic Airways for two more Comets, one of which was delivered last year. The second will be handed over shortly.

Railway Modernisation in Sheffield Area

Modernisation of the British Railways freight system in the Sheffield area is to begin in the late spring. In a £9 million master plan the EASTERN REGION intend to create a new marshalling yard and diesel depot at Tinsley and a concentration depot for freight at Grimesthorpe. The plan is to be carried through by the end of 1964.

Delivery times on services as far afield as London, South Wales, and Tyneside are expected to be cut substantially. Operational savings should amount to around £900,000 a year.

Repeat Viscount Orders from Japan and Germany

ALL NIPPON AIRWAYS, the Japanese airline, have placed a repeat order for three Viscount 810 turboprop airliners with the BRITISH AIRCRAFT CORPORATION. At the moment, All Nippon is operating two Viscount 744s on lease while it awaits delivery in the summer of its first three Viscount 810s, ordered almost a year ago.

The new contract was signed in Tokyo for All Nippon by the merchant company MITSUI BUSSAN KAYSHA.

In Western Germany, LUFTHANSA is bringing its Viscout fleet up to ten with the order for another Viscount 810.

These two contracts bring the number of Viscounts sold or definitely ordered up to 429. They are operational from 38 countries, and from 59 operators, six private companies and five governments.

Acrow V-Formwork

To be successful a product for the building industry must show a definite financial economy. The V-form system of concrete shuttering has proved itself for flat slab floor construction.

ACROW V-Formwork is associated with the growing trend towards flat slab floor construction. In most instances it enables the time and cost of laying such a floor to be considerably reduced. Though V-formwork can be used for other types of flat slab construction, it is with floors that it gives its optimum benefit.

Whatever the relative merits of flat slab floors, the popularity they have gained in the USA is now spreading to this country. The swing towards flat slab instead of beam construction for the floors of large office and residential blocks has become particularly noticeable in Britain over the last 12 months, and roughly three out of every five such buildings now being erected have such floors.

Acrow (Engineers) Limited, of London, W2, believe that by introducing the V-formwork system into this country, they have made a significant contribution towards the favourable economics of flat slab floor construction. ENGINEERING therefore set out to find out how V-form originated and what part Acrow played in its development, though the word " development," as normally used in Product Profile, perhaps hardly applies in this case since the finished product is so little altered from the simple basic conception.

Choice of the type of floor construction for any new multi-storey block tends to depend more on the general architectural and constructional features than on the cheapness or convenience of the different construction methods open to the contractor. Under favourable conditions, the Acrow V-form shows a big saving in time and cost over any other method of shuttering up a flat slab floor. But the inherent remoteness in the relationship between the customer and the building designer in this country is such that the existence of V-form is unlikely to govern the choice as to the floor type, even though substantial savings in construction costs could result from a closer alliance.

There are basically two other ways of shuttering up a flat slab floor besides the V-form method. One is by using plain timber boards butted up against one another and supported by a forest of props and beams. Its chief disadvantage is that it has to be erected piecemeal or in premade panels, involving a large labour element; but, even today, there is often no other alternative for dealing with small and awkwardly-shaped overhead areas. The other is by the use of plywood sheets or panels carried on metal floor centres, self-supporting over a bigger span to dispense with some of the props and beams. The main difficulties in this system lie in getting the underside of the slab flat due to the camber in the floor centres, and supporting the beams.

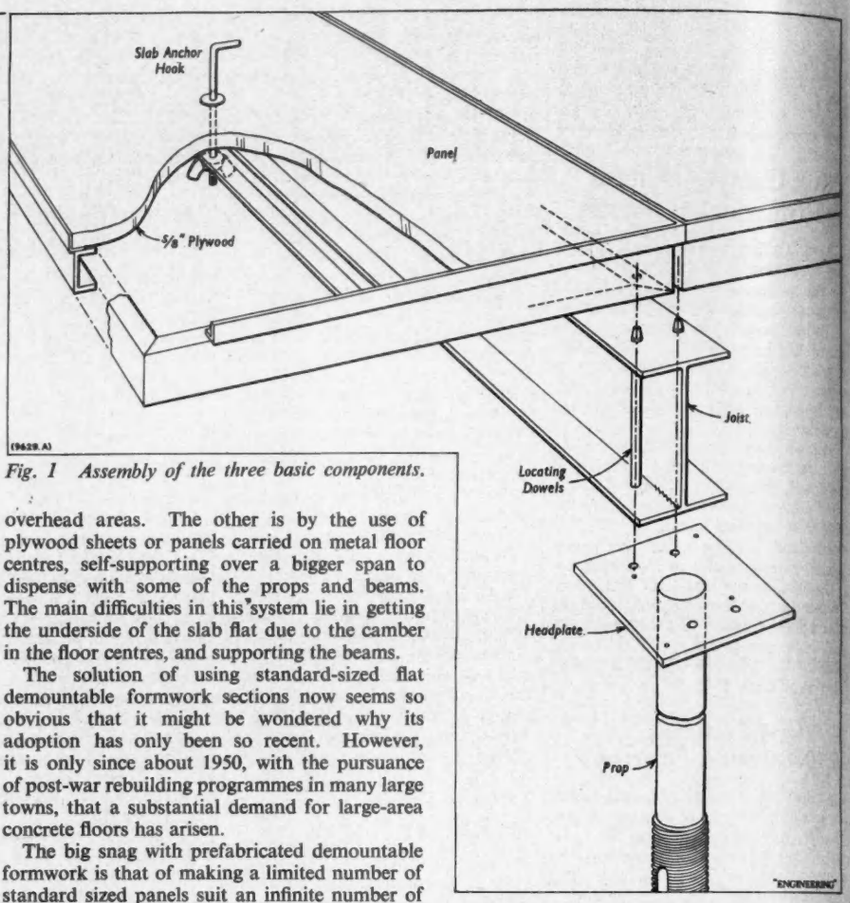


Fig. 1 Assembly of the three basic components.

The solution of using standard-sized flat demountable formwork sections now seems so obvious that it might be wondered why its adoption has only been so recent. However, it is only since about 1950, with the pursuance of post-war rebuilding programmes in many large towns, that a substantial demand for large-area concrete floors has arisen.

The big snag with prefabricated demountable formwork is that of making a limited number of standard sized panels suit an infinite number of different sizes and shapes of concrete floor. Thus, while the five different panel sizes Acrow produce will cover the greater part of any floor area, timber make-up has to be used around the edges. Further, a floor bonded on four sides by protruding beams is far less convenient for V-formwork than one bounded on only two sides. So the suitability of V-formwork for any floor is governed by the nature of its boundaries as well as its main dimensions.

This disadvantage of standardised formwork sections is not new, neither can it be said that Acrow have developed any new way of overcoming it. They have, however, realised that despite the disadvantages of using standard formwork sections, it had to come eventually with the growing use of flat slab floors. Acrow's success has been achieved by realising this and using a vigorous sales policy to launch it commercially. Under favourable conditions, up to 40 per cent saving in labour can be attained by using V-formwork. But its choice for any particular job will depend ultimately on overall cost, which will depend in turn on the make-up required and the additional costs it will impose.

Flat slab floor construction was originally evolved in North America about ten years ago in order to eliminate secondary floor beams. Strength was maintained by using stronger reinforcement coupled with a slight increase in the thickness of the slab.

It was therefore natural that the basic idea of the V-formwork system should also originate over there, and it was first introduced by Acrow Denver Incoporated about 1955. It was not long before its possibilities were recognised by other Acrow member firms, including the one in Britain. This company was originally formed about 25 years ago to manufacture and sell the Acrow prop for the building industry, shown prominently in Fig. 4. Its design was introduced into this country by Mr. W. A. de Vigier, the company's founder, who is the present chairman and managing director. So outstanding was the success of the prop that it soon became known all over the world as simply the " acrow," and despite the firm's subsequent diversification it is still one of their most important products.

Subsequently formwork systems were devised, all using the acrow, including floor centring, wall forms and scaffolding systems. When flat slab floor construction started in Britain, what could be more natural than the exploitation of the

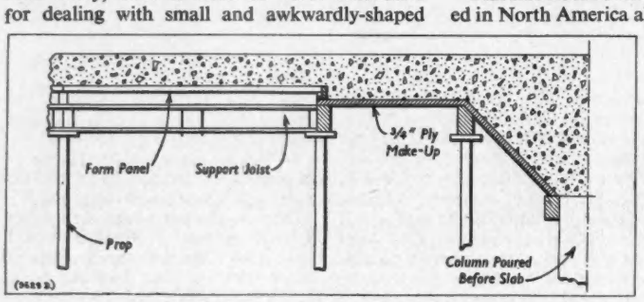


Fig. 2 (left) Combining V-forms with conventional formwork for drop-heads.

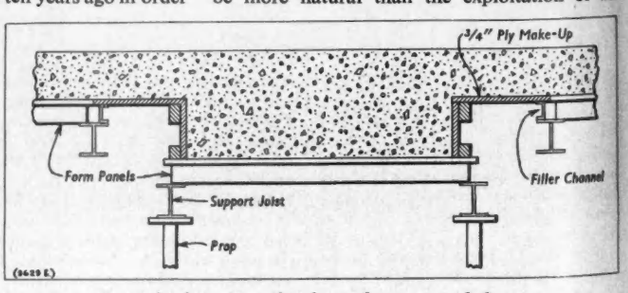


Fig. 3 (right) Use of V-forms for extra wide beams.

Fig. 4 Where success depends on a basic simplicity resulting in expediency on site.

V-form system, still using the same acrow as a basic component?

Acrow quietly started to manufacture V-forms and launched them on the market in January, 1958. Detail modifications were made to the American design but the basically simple idea remained unchanged. The name was adopted for the sake of giving the newcomer a distinctive name, the " V " standing for versatility.

It is worth mentioning that in the last ten years or so Acrow's diversification policy has been greatly intensified, leading the company into many new fields.

COMPONENTS

The inherent simplicity of the V-formwork system cannot be better illustrated than by Fig. 1. It consists of three basic components: the prop, the joist and the panel.

The props are merely standard acrows, or " shores " as they are sometimes termed, all of which are now provided with four holes in the head plate for registering the V-form joist dowels. They consist essentially of two telescopic tubes with a central pin and screw adjustment device which permits infinite variation in height, between limits. Acrow also supply drilling jigs for customers owning props with blank head plates, made before V-formwork was introduced.

A patented self-cleaning device on the adjusting collar nut clears the acme thread of dirt and concrete as the nut is rotated. The collar nut has a holed boss for ready manipulation when using a bar in a confined space. For providing the props with the necessary rigidity it is customary to brace them together using standard scaffold tubes and clamps, as shown in Fig. 4.

The joist is a 6 in by 4 in seam welded mild steel section weighing roughly 8½ lb per foot run. A pair of double-ended dowel pins passing through both flanges at each end serve the dual purpose of registering with the holes in the head of the prop and in the panel, and also providing extra strength at the ends where accidental damage is most likely to occur. No fixing bolts are required.

In America the 6 in by 4 in section is a standard rolling, and from the time of introduction of V-formwork into Britain up to about a year ago Acrow imported the joists. Though more expensive than buying from America, joist fabrication eliminates the wide tolerances associated with rolled sections, and safeguards adequate supply. This procedure was adopted without altering the price to the customer. The dowel pins are mild steel with tapered ends for easy fitting and are welded to the inside faces of each flange. The fitting clearance is $\frac{1}{16}$ in on the diameter, and joists are supplied in three standard lengths of 4, 6, or 8 ft.

The panel consists of a plywood face held in a rectangular steel frame with holes on the underside positioned to suit the joist dowels. All panels are 2 ft wide and can be supplied in any length between 2 ft and 6 ft in multiples of 1 ft, though the two shortest lengths are only made to order. The 6 ft panel is the heaviest single V-formwork item and weighs 81 lb with ply.

The frame is fabricated from 2½ in by 1 in rolled steel channel with a ¾ in equal rolled steel angle welded along the top edge. The angle provides continuous edge protection to the ⅝ in thick plywood face insert, and, since it has a square-cut internal corner and square-cut edges, the plywood can be reversed when one face has become unusable. Acrow claim that the ply should survive at least 40 periods of usage before requiring replacement, and probably many more, depending on the grade of the material.

Securing the plywood to the frame is generally by screws but Acrow now offer the customer a choice of nails, screws or bifurcated rivets to his own requirements.

The three basic components can be supplemented by various clips and fastenings aimed mainly at increasing convenience and versatility. One in particular, the slab anchor hook, is an important aid in floor construction. It is cast in with the floor slab to hold the panel in position while the formwork is being struck, for reasons of safety for the workmen. The hook has a " break-back " beneath the surface of the slab to allow subsequent removal of the protruding portion.

Summing up, the chief technical advantage of using V-formwork where the job is suitable is the ease and safety of erection and stripping; work which requires little supervision and leading to substantial economy in labour costs.

One good selling point that Acrow recognise is the provision of a drawing office service. Once contact with the prospective customer has been established through a travelling representative, he is invited to send in a drawing of the building, from which Acrow prepare a detailed layout and estimate based on the type of formwork they consider most suitable. On occasions alternative schemes may be offered; and Acrow also run a service for special applications. The contractor's choice of V-formwork, for example, may therefore be partly governed by the service that goes with it in addition to its technical advantage. Once the contractor has invested in a set of V-form equipment there is no reason why he should not use it how he pleases, for example, for concrete walls and buttresses, or floor beams, though this is not recommended.

Acrow is now a large organisation devoted to the manufacture and sale of a diverse variety of products. They have eleven depots and branches covering Britain, and 18 associate companies overseas as well as representation in 76 other countries. There are five UK factories, one at Saffron Walden in Essex being used mainly for formwork production, including V-forms. With V-form the emphasis is on quantity production to keep the price acceptable to the customer, and comprehensive special tooling is employed. Accuracy of the welding jigs, and jigs locating the dowel holes, is strictly supervised, and all components are tested before despatch.

Once over the first year sales of V-formwork began to show promise and now production is having to be expanded all the time to keep up with demand. The order book is full and delivery time on V-form is about two months at present. Most of the leading building contractors in this country have recently invested in quantities of V-formwork, in some cases after a thorough practical investigation of its merits. George Wimpey and Company, for instance, made exhaustive studies of the system on site before committing themselves, proving that under favourable circumstances V-formwork fully justifies the claims of labour saving advanced for it in flat slab floor work.

There is no doubt at all that V-formwork has a big future ahead of it. Current architectural trends in office block construction, such as curtain walling and movable partitions within, generally tend to favour flat slab floors; a movement in which V-formwork will share.

Fig. 5 (right) Using a three-man erection team.

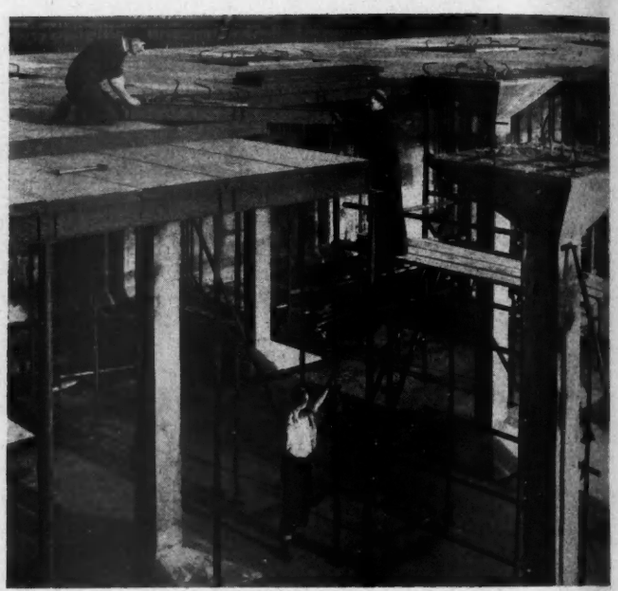


Fig. 6 (left) The customer can easily fix his own plywood.

Irradiation Effects on Semiconductors

The possibility that irradiation can be used to introduce chemical impurities in certain semiconductors is being explored at the Oak Ridge National Laboratory in the USA. Besides alterations in the electrical properties caused by induced transmutation products, lattice defects are created by recoil of excited nuclei when emitting radiation after capturing neutrons. In view of the possible future importance of semiconductors in connection with earth satellite communications systems, the value of an understanding of transient processes in semiconductors is evident.

Information on the fundamental behaviour of semiconductors with appropriate nuclear properties can be obtained from thermal neutron irradiation. The fixed rate of radioactive decay after irradiation with thermal neutrons permits observations of time-dependent electronic properties. The rate of shift of chemical potential with impurity introduction may be used to determine the ionisation energies of defects or impurities.

Carrier concentration measurements on germanium have been employed to verify the neutron absorption cross-section, the decay scheme and the half-life predicted by theoretical physics. Minority-carrier life-time, i.e., a measure of the time required for a disturbance in the concentration of electrons or holes in a semiconductor to relax toward equilibrium, is one of the most sensitive indications of any lattice defects in semiconductors.

Lifetime measurements have been used to investigate the electronic structure of irradiation-produced lattice disorders. One of the more notable results of these studies has been the observation that chemical impurities, present in germanium to the extent of only several parts in 10^9, have an important influence on the course of annealing radiation-produced lattice defects at temperatures near 100° C.

Various types of chemical impurities have been found to have differing specific effects. This evidence of extensive interaction between imperfections, which are present in such low concentrations, indicates the need for a better understanding of the principles of defect migration in semiconductors and long-range interactions.

New High-Speed Wind Tunnel

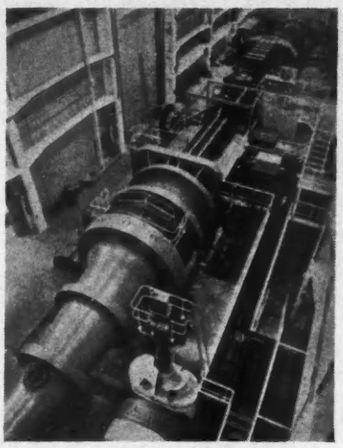
A new 4 ft by 3 ft closed-circuit wind tunnel at the Royal Aircraft Establishment, Bedford, was opened on 24 March by the Rt. Hon. Peter Thorneycroft, MP, Minister of Aviation.

The working-section leg of the tunnel, which is over 150 ft long, is comprised of the inlet and contraction sections, nozzle, bridle structure, model-support section, supersonic and subsonic diffusers and outlet section. The contract for making these items, which was worth over £1 million, was awarded to the General Electric Company. The same firm is also supplying a calibration section for examining the air flow pattern; this unit will be interchangeable with the model-support section in the line of the tunnel.

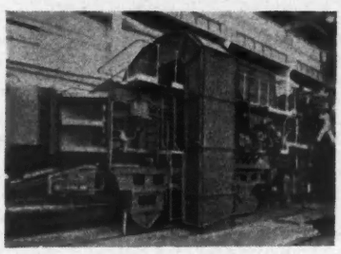
At present, the tunnel is operating with a fixed throat gap and contour nozzle, made by the Ministry of Aviation, which gives a nominal air speed corresponding to Mach 4. The GEC contract includes a flexible plate nozzle, now being built, which will cover the speed range between Mach 2·5 and 5·0. The 8 ft by 8 ft wind tunnel at Bedford, which was commissioned a few years ago, has a maximum Mach number of 2·8.

One of the principal features of the new facilities at Bedford is that maximum availability of the tunnel has been provided for testing work. Since the rigging of a model with its instrumentation may take a considerable time, it is essential that the setting-up should take place outside the tunnel, while the tunnel is actively used for other test work. For this reason, all the arrangements for the mounting, manipulation and instrumentation of the models are incorporated in a number of separate and interchangeable model supports which can be quickly disconnected and removed bodily from the air circuit to an adjacent rigging bay.

Another important feature of the new tunnel



View of the new RAE supersonic wind tunnel, taken from the inlet-section end.



A section of the working leg of the tunnel, showing the supersonic diffuser, the air-release valve ducting and, at the right, the model-support section.

is that the whole of the working-section leg is anchored at one point only, namely the model viewing position, and both upstream and downstream of this point the various casings are mounted on wheels running on machined rails. This not only allows easy opening of the tunnel for interchange of model-support sections, but also accommodates the thermal expansion which takes place at high temperatures.

Greater Use of Tantalum

With its high melting point, 2,996° C, and retention of plasticity down to − 196° C, tantalum offers the greatest temperature range of structural usefulness of any metal. Though already in general use in various electronic applications, the metal's most immediate potentialities appear to lie in the use of its alloys in high-temperature environments. As a material of construction, tantalum's main prospect would appear to be in the temperature region just below that served by tungsten and above that served by the lower melting-point alloys of molybdenum and colombium.

According to a research metallurgist at the Battelle Memorial Institute, Colombus, Ohio, USA, tantalum shows extensive solubility for use with many high-temperature strengtheners including tungsten, colombium, molybdenum, vanadium, hafnium, and zirconium. Moreover, it has good tolerance for impurities such as carbon and oxygen. These features make tantalum less susceptible to contamination during processing than some other metals. The metal's disadvantages are its high density, costliness and limited oxidation resistance at high temperatures. Tantalum alloys require protective coatings in oxidising environments.

Several tantalum-base alloys with excellent high-temperature potentialities have been developed. Thus, a 30 Ta—5 Cb vanadium alloy is particularly attractive because of its low density compared with tantalum.

At temperatures between 1,200° C and 1,400° C, tantalum alloys are expected to have strength-to-weight ratios at least as great as columbium alloys; and they should have greater strengths at high temperatures. Indeed, because of tantalum's high melting point, its alloys may find use in the 1,400° C to 2,200° C range; where tungsten alone serves as a metallic material of construction.

Automatic Ash-Content Analysis

An automatic coal-analysis unit has been developed for the Netherlands State Mines. It consists of: a sampling unit which takes a representative sample from the run of coal; a conditioning unit which dries and grinds the coal; and an analysis unit.

The operation of the analysis unit is based on the difference in the reflection of X-rays by combustible and non-combustible components. The samples are conditioned and fed continuously to a rotary disc exposed to an X-ray beam. The reflection of the various components is compared, by photoelectric method, with that of a reference sample. The difference is recorded on a strip chart and read, simultaneously, on a meter calibrated in ash per cent. The measured data can also be used to assure the automatic control of coal-washing plant.

The manufacturer of this equipment is N.V. Rontgenapparatenfabriek Evershed-Enraf, Van Leeuwenhoeksingel 69, Delft, Netherlands.

Welding Cast Iron to Steel

It is well known that arc welding, even of the shielded type, is not able to give satisfactory results for the welding of cast iron to steel. Not only does the cast iron penetrate into the weld joint, but the rapid cooling rate of the joint tends to favour the formation of chilled cast iron.

A Russian welding institute has recently made some experimental comparisons between arc welding and electrical resistance welding and has succeeded in obtaining strong joints with the latter technique. Cast-iron carburettor components were, after complete machining and cleaning, flush welded to steel tubes. The parts were preheated by repeated short circuiting and then flush welded.

The technical details of the electrical resistance welding process are as follows: the chucking length for steel tubes was 50 mm; for cast-iron parts it was 120 mm; the transformer power was 85 kVA; the transformer voltage was 5 to 6 volts. The preheat cycle lasted 10 seconds and the flush cycle 4 seconds. Material allowance for the welding process was 3 to 4 mm.

The welded components were rapidly shop tested by peening the steel adjacent to the weld. They were then subjected to thorough metallographic and tensile testing.

Significant of the results obtained with the flush welding method was the fact that arc welded joints were destroyed under loads of 0·8 to 1·0 tons, whereas the flush welded joints withstood loads of 3·3 to 4·6 tons.

The process requires further investigation in order to clarify the relative effects of preheat and cooling rate, but it is already apparent that the process will permit considerable gains in productivity and product quality.

Buchman, J. "Das Verschweissen von Gusseisen mit Stahl," *Promyschlenno-Ekonomitscheskaja Gaseta*, USSR, January, 1960.

Wider Use of Hydraulic Investigations

Michelangelo once said "a builder's most blessed expense is the money spent on models." Nowadays this is true of nearly all branches of applied science, but for the civil engineer models may be the only direct means of investigation available.

THE technique of utilising models as an aid to design is now well established but ten years ago it would have been true to say that, in civil engineering, engineers in Great Britain were not exploiting the value of hydraulic research to the same extent as in Europe and America. Before 1950, this was largely due to the lack of special facilities for undertaking the work, and it was all the more regrettable since hydraulic models were used first in this country and a classic study is the work done by Professor Osborne Reynolds in 1885, working with a model of the River Mersey at Manchester University. British engineers in India were making extensive use of model studies, however, for the vast irrigation works constructed in the Indian sub-continent between the wars.

In 1945, a memorandum from the Institution of Civil Engineers stated that while hydraulic research had been extensively developed abroad, there had been no parallel advance of facilities in this country. Between 1900 and 1928 many German universities established hydraulic departments, each larger than any in Great Britain. The Germans were also first to realise that such work required equipment and facilities beyond the scope of Universities and that special research stations were required. Long before the Second World War the Corps of Engineers of the United States Army built the first of a series of experimental stations at Vicksburg, and the Dutch established a laboratory at Delft to cater for their special requirements; in 1930 the French had both Governmental and commercial laboratories specialising in hydraulic research, and several large hydraulic research stations were established by British engineers in India. However, as a result of the Institution of Civil Engineers' memorandum, the Department of Scientific and Industrial Research appointed Sir Claude Inglis, C.I.E., M.I.C.E., Director of Hydraulic Research and formally opened the Government Research Station at Wallingford in 1951.

The Wimpey Hydraulics Laboratory commenced as an internal service to the company on matters relating to site investigations and constructional problems. In 1954, the construction and operation of hydraulic models began on a commercial basis; today, of the numerous investigations in progress, the majority are independent commissions from eminent British consulting engineers. The range of subjects which are studied is large and covers the problem of tidal flow and the maintenance of navigation channels at ports, wave action and the stability of breakwaters, coastal hydraulics and the behaviour of sea defence structures; many aspects of hydraulic design involved in irrigation structures, river training, water supply and hydro-electric schemes and other miscellaneous problems embraced in the general term "loose boundary hydraulics."

Applications

Model techniques, are of course, not exclusive to the field of civil engineering; aeronautical engineers check their designs by model tests in wind tunnels, ship designers verify prototype performance in towing tanks and the mechanical engineer tests models of turbines and pumps in order to predict the performance of the full size machines.

Owing to a number of complex factors in the design of hydraulic structures, satisfactory answers to various problems cannot yet be obtained by analytical methods. The use of hydraulic models, normally varying in scale from 1 : 5 to 1 : 5,000, presents the engineer with an effective and handy tool for the solution of a problem. It is not proposed to discuss here the theoretical background of the work since it is fairly well known and, in any case, has been adequately covered in many publications. This Research Report is intended to present the broad concept of a hydraulic laboratory as a vital adjunct to the planning and design of civil engineering structures rather than the limited consideration of models as small scale reproductions of prototype structures. The cost of a model investigation is very small compared with the value of improvements which may result from the tests and it also provides an added assurance, to both client and engineer.

The special function of the Hydraulics Division of the Central Laboratory is the interpretation and translation of research undertaken by universities and by government research stations throughout the world to practical problems in the design and construction of hydraulic works, and to give the engineer the required information with speed and economy. Four widely differing types of investigation are described below and related to recent model work undertaken by the Hydraulics Division.

Salaverry Harbour, Peru

Two investigations have been undertaken in connection with the design of a new harbour at Salaverry, for the Peruvian Government. They provide an interesting example of close collaboration in site observations and model investigations, at an early stage in the design of harbour works. The port is sited on a coastline virtually devoid of any natural features which might afford protection from the prevailing storm direction. During storms, long-period swell waves, reaching up to 5 metres in height trough to crest, invariably approach the coast from the south west. The first model studies were confined to conventional examinations of the effects of wave action within the harbour on different layouts. A 1 : 100 natural scale, rigid bed model was used for this work and the tests led to recommendations being made on the desirable length of a breakwater and the best alignment of the proposed jetties.

It was known that the construction of a breakwater would result in changes to the normal pattern of beach movement and an investigation was made by means of a mobile bed model. After commencement of the contract, regular sounding surveys and current observations were undertaken in order to provide additional data.

After preliminary tests with a small pilot model, a horizontal scale of 1 : 200 was chosen for the mobile bed model. It is well known that in the case of mobile bed studies, the slopes and velocities resulting from the use of an undistorted model are usually too small to simulate prototype movements. The solution is the adoption of an exaggerated vertical scale. Site observations indicated that erosion and consequent deposition were closely related to wave action and wave induced currents, and very careful consideration had to be given, therefore, to the degree of vertical exaggeration which could be introduced into the model, and to the choice of bed material.

Fly ash was chosen as a bed material and this was found to move readily under the action of relatively small waves. A vertical scale of 1 : 75 was selected by relating the slope of a model beach formed from fly ash and subjected to scale waves, to the slope of the fine sand beach of the prototype. A slightly higher velocity scale than that indicated by the Froude Law was introduced in order to obtain realistic transport of the bed material. This was achieved by increasing the model wave height above the value determined from dimensional analysis, using the vertical scale as the critical parameter.

As the new rubble mound breakwater was built out from the shore, changes occurred in the beaches to both north and south of the breakwater. As anticipated, there was an area of reverse drift immediately leeward of the breakwater, and there was erosion of the beach north of the harbour. The construction programme allowed for establishing No. 1 groyne prior to the completion of the breakwater and this was effective in preventing the deposition of material at the existing jetty. It is interesting to note that as the breakwater approached completion, sand was deposited at the end of No. 1 groyne. The same accretion occurred during the model tests with this groyne alone. Other tests indicated that the construction of all three groynes shown in Fig. 4 would substantially reduce the quantity of material entering the harbour as a result of wave action. Since completion of the three groynes a systematic

Research Report

on the work of the

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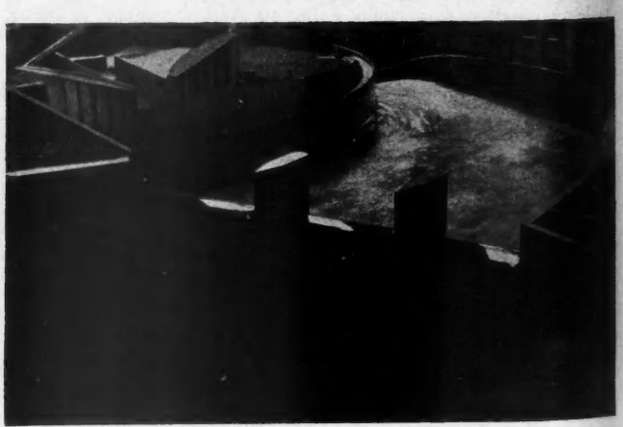


Fig. 1 (Right) Model of Loch Turret Spillway from reservoir. This system was required to return excess water back into a river course.

check by soundings has been made. This has shown that for two years the sea bed topography in the area has remained stable. The ultimate development of the harbour involves the construction of a northern breakwater which will incorporate the northernmost groyne and this final layout was also examined during the model investigations.

Surge Chamber

A completely different technique to the systematic rigorous testing necessary for the Salaverry investigation, was used for examining the flow characteristics in a proposed surge chamber layout. Quite frequently, a close visual examination of the performance of a model will provide the design engineer with most of the required information. It is possible, of course, for the visual interpretation to be substantiated and given quantitative values by later tests but, nevertheless, the real value lies in the three dimensional presentation and behaviour of the prototype structure. Such work is usually relatively cheap and invariably the cost is an insignificant fraction of the expenditure incurred in the main works. In this instance it was desired to observe and compare the performance of an existing and a proposed surge chamber arrangement, with particular reference to the relative head losses through the systems and the velocity distribution in the high pressure shafts downstream that are located of the surge chambers.

This work in connection with the Strathfarrar and Kilmorack Project, was undertaken to the instructions of Sir William Halcrow and Partners, consulting engineers to the North of Scotland Hydro-Electric Board. The models were constructed in Perspex and the flow pattern in the tunnels was recorded by using photographic tracers with a high speed ciné-camera. Later, when this film was projected at slow speed, it was possible to make a detailed analysis of conditions which occurred in the model too quickly for the eye to see. This technique is frequently used in model research since it provides a convenient method of slowing down model occurrences (which have to be operated many times faster than the prototype in accordance with a time scale determined from consideration of the linear scale) to that of, or slower than, the prototype.

Gharraf Regulator, Iraq

Irrigation control structures such as sluices, weirs, regulators and pumping stations frequently

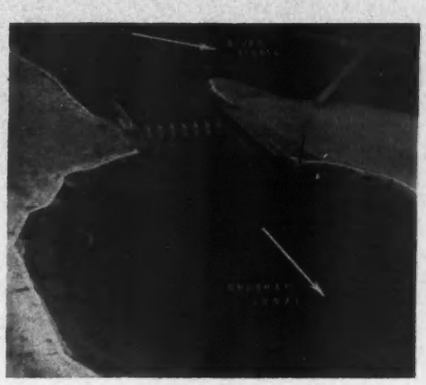


Fig. 2 Headworks in model of Gharraf canal.

give rise to complex problems in hydraulic design because of the variable flow conditions in which they require to be operated. Extensive use is made of hydraulic models to test proposed designs under the full range of flow and water level conditions likely to be encountered on site. Typical of this class of investigation, the Gharraf head regulator is currently being examined by means of model investigations conducted on behalf of Sir Murdoch MacDonald and Partners, who are consulting engineers to the Iraq Government.

For many years, a thriving agricultural development has been possible as a result of the construction of the Kut barrage on the River Tigris. On the right bank, immediately upstream of the barrage, the Gharraf Canal draws off a regular supply of impounded water for irrigation purposes. The flow through the canal is governed by a seven bay regulator, and severe erosion of the channel bed has occurred immediately downstream of the headworks. The design depth of the channel was 3 metres but a 20 metre deep scour hole has developed downstream of the apron, accompanied by severe erosion of the banks.

The model investigation is being conducted in three parts: (*a*) a two-dimensional flume study to verify discharge characteristics with a modified sill design, (*b*) a rigid bed 1 : 75 natural scale model for examining velocity distribution and eddy formation at various river stages (Fig. 2), (*c*) a mobile bed study using the same model as in (*b*) but with the river and channel depths enlarged to give an exaggeration of the vertical scale. Possible remedial works will be examined by a process of trial and error with the aid of the mobile bed model.

Loch Turret Spillway

As with hydro-electric work, water supply forms a specialised branch of civil engineering and the hydraulic design problems are as complex as in any other field. The Division undertakes numerous model research programmes associated with pipe flow, air entrainment, surge tank design and overflow spillway works.

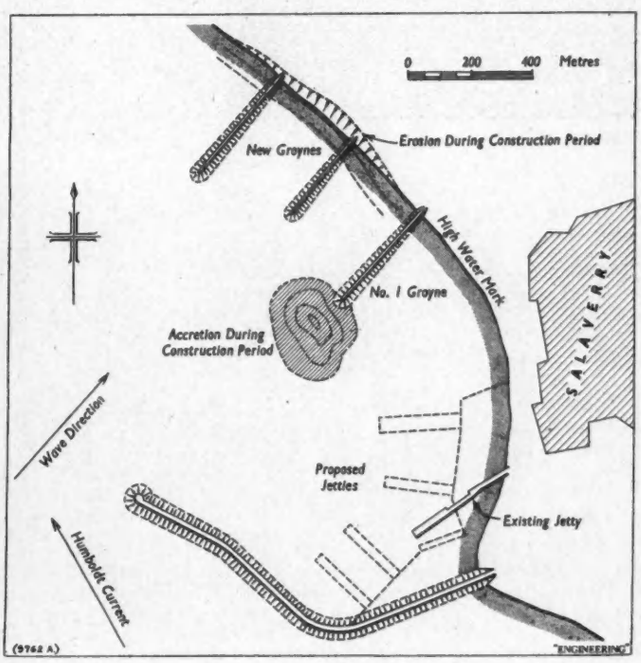
A 1 : 25 full size model was used in a recent investigation of a proposed spillway design by Babtie Shaw and Morton, consulting engineers to the Loch Turret Water Board (Fig. 1). The spillway system was required to return water in excess of storage requirements back into an old river course. The model tests were used to examine the flow characteristics over the spillway weir and the subsequent flow down the sloping channel which, in plan, had to be both curved and tapered at the upstream end. The data obtained during this investigation assisted in determining the best plan shape of the spillway channel, the heights of the side walls and the optimum channel slopes. It was found to be particularly important to maintain sub-critical velocities in the upstream section of the spillway, where the channel converged and deflected through 60°, in order to prevent strong reflections from the side walls.

Site Surveys

The Hydraulics Division has operated a hydrographic survey team for many years, the work often being closely related to other marine activities of the company. The team uses conventional echo sounding and current measuring equipment, together with special apparatus for obtaining data on salinity, silt content, sea water temperature, etc. Much of the work undertaken on site is not directly concerned with model investigations and ranges from sounding surveys for harbour works or power station outfalls to river gauging and the preparation of flood hydrographs. However, to the Laboratory, the real value of the survey team's activities lies in the experience obtained in site conditions when surveys are required before commencing a model investigation. During early stages of operation and calibration, when a model may give apparently anomalous results, a detailed knowledge of the prototype is then of immeasurable value to the success of the investigation.

Fig. 3 (below) Waves eroding the fly ash beach in the model of Salaverry Harbour.

Fig. 4 (right) Plan of Salaverry Harbour, Peru. A 1 in 100 natural-scale rigid-bed model was used.



Power for Kitchen and Table

COMPARATIVE newcomers to the range of domestic equipment are the items that make up the Luxury Life series produced by S. N. Bridges and Company Limited, York Road, London, SW11. One of these is the food mixer shown in the top right illustration.

Small and portable, the mixer works from standard mains supplies. In spite of its size it is robust and will do most mixing jobs. Another great advantage is that it is easy to clean. The storage problem is virtually eliminated as the tool is simply hung up after use.

The basic head has four straight blades set at an angle to give a stirring action. To them can be added several attachments. A whisk is said to complete a cake mix in 2 minutes or a mayonnaise in 15 seconds; a beater will whip cream in 35 seconds; a mincer will cut vegetables for soup in 40 seconds and a coffee grinder attachment will grind enough for four people in 1 minute. The driving motor is rated at 100 watts and the body measures 2¾ in diameter with an overall height of 11 in. Other items in the Luxury Life range include a fan heater, hair dryer, electric blanket and a series of table top

cooking appliances—saucepan, skillet and griddle, all thermostatically controlled.

The latest power driven accessory for the dining table (a battery driven carving knife with a reciprocating blade was announced at the end of last year) is " Peppy " which saves the gourmet the trouble of hand grinding his pepper in the mill. Peppy stands 8 in high with a conventionally shaped body of cherry wood. At the top is a brass push button to start the grinding motor and round the middle is a brass belt where the peppercorns are inserted. The makers state that a child can operate it easily. Peppy is supplied by General Trade Equipment Limited, 82-90 Seymour Place, London, W1.

Another power-driven table-top accessory is a pencil sharpener. It was introduced at the recent Stationery Trade Fair in London and is being distributed by British Pens Limited, Smethwick 41, Staffordshire. The makers are Kent Kordless Limited. For those who like to have their pencils really sharp all the time—and also for places where there are many pencils to sharpen—the unit should prove very useful and frustration removing. Only one hand is needed, the pencil is simply pushed into the hole and the pressure automatically starts the motor. The unit measures 4½ in by 3½ in by 3½ in so that it is easily portable. For this reason it is suggested that shorthand writers might find a particular use for it. Spare batteries and blades are available.

Continual replacement of batteries can be a costly business if it becomes frequent and Chilton Electric Products Limited, Hungerford, Berkshire, have therefore introduced the Permabeam rechargeable cell of the cartridge type which measures 4¼ in long by 1¼ in diameter. This is the same size as two standard U2 batteries. It is made in a blue plastic durable case and consists of a series of nickel cadmium button type cells which are equipped with normal

(*Above*) *The Luxury Life food mixer is light to handle.*

(*Left*) *Pencils can be automatically sharpened in a battery driven machine.*

(*Below*) *"Peppy" is a battery driven pepper mill for the table.*

battery contacts and a two pin plug for recharging.

Four models are being made all with the same physical dimensions. The standard one is rated for 2·5 volts and the three others at 3·5, 5, and 6 volts respectively. They can all be recharged simply by plugging into a mains socket (110-240V ac) and leaving overnight. They have a long guaranteed life. It is claimed that there is no deterioration or corrosion, that the store life is indefinite, and that they are shockproof. Recharging costs are negligible and the cells are clean to handle.

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Published every Friday by Engineering Ltd. at 36 Bedford Street, London, WC2, England.
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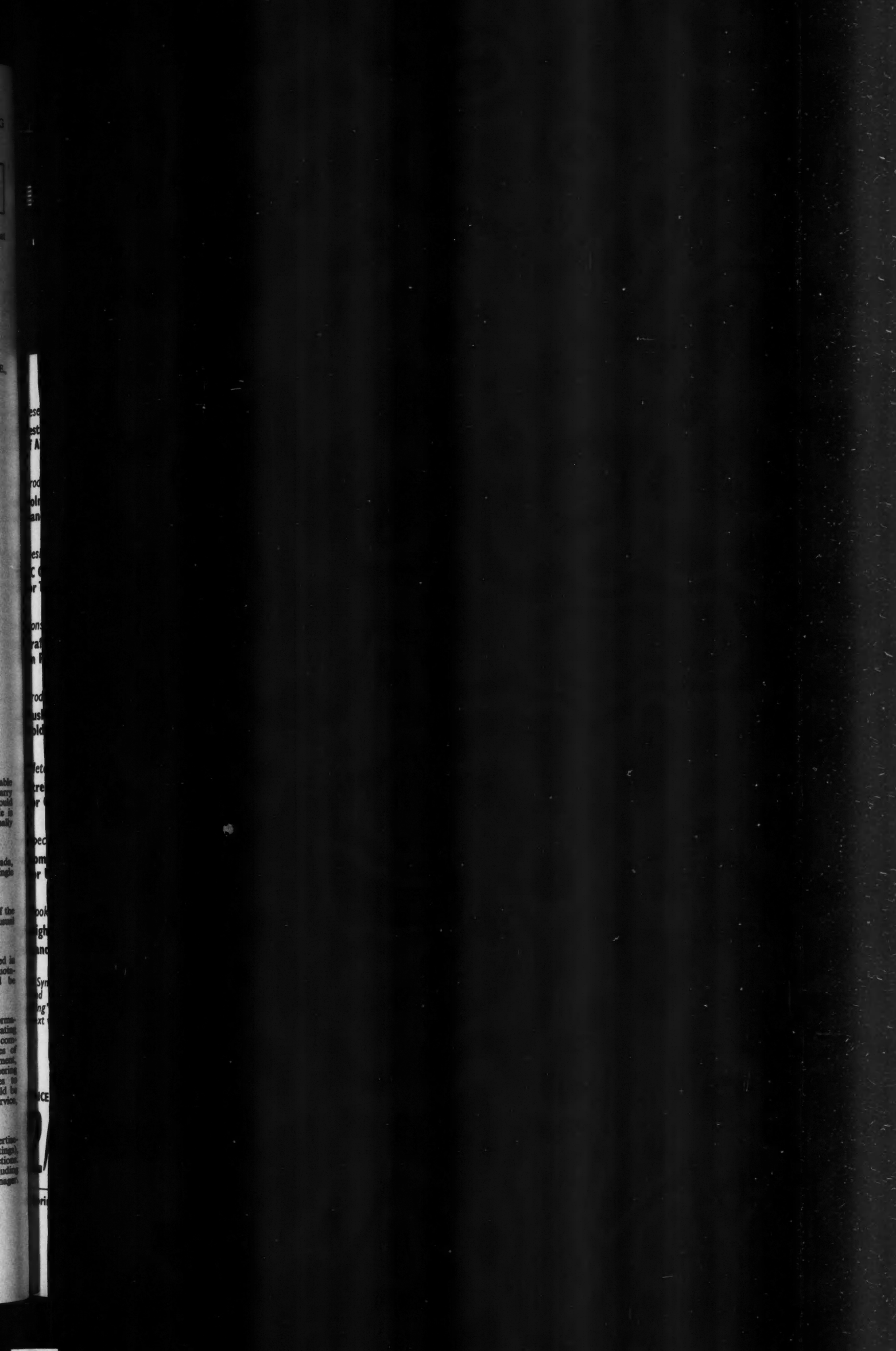
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